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THE RESPONSE OF RICE VARIETIES TO SEASON OF PLANTING[1]

P. B. ESCURO[2]

WITH TWO TEXT FIGURES

The relations between number of days to heading and plant height and of these characters with their respective annual ranges were studied and used as bases for predicting the seasonal reaction of 251 varieties in bimonthly plantings under irrigated field conditions. The correlation coefficient between days to heading and its annual range for the March planting ($r = .970$) was sufficiently high for use as a basis for predicting annual heading range from days to heading and, hence, the seasonal reaction of rice varieties. The r values between days to heading and its annual range for the other plantings, between plant height and its annual range, and between heading and plant height for all plantings were all significant but still low for prediction purposes.

By plotting the date of planting against days to heading of any variety that has been classified into any maturity group in March planting, the days to heading of that variety, when planted any time between March and December, could be approximately determined with the use of the curves for the maturity groups.

Selection of the best time for planting a rice variety to obtain optimum grain yield presents a difficult problem to both researchers and growers. Obviously, this date could be determined through a study of the actual performance of a variety grown in a series of trials, but this is a slow and expensive procedure. Previous studies indicate that reduction in yield due to late or off-season planting is much greater among lates than among earlies; that is, the late varieties are seasonal (Abesamis, 1922; Gotera, 1930; Jenkins *et al.*, 1944; Jodon, 1953). The problem is to determine the latest date of planting to be able to screen seasonal reaction effectively; and with regard to the seasonal varieties, the date which will give optimum yield. The relationships between days to heading, plant height, and number of tillers, three of the important characters influencing yield (Vibar, 1921; Capinpin, 1923; Brewbaker *et al.*, 1953; Ramiah and

[1] Central Experiment Station Contribution No. 2037.

[2] The writer is grateful to Miss Rosa C. Dumlao, Research Assistant in the Department of Agronomy, for her help with the statistical computations.

Rao, 1953), and between these traits and their respective annual ranges were studied in bimonthly plantings to determine seasonal response and to predict the days to heading of the seasonal varieties.

MATERIALS AND METHODS

A total of 206 upland and 200 lowland varieties were planted under irrigated conditions, approximately every two months over a one-year period starting March 29, 1955. Because of poor germination, disease, and pest damage on certain varieties in one or more of the trials, only 251 varieties were used in the study. The varieties, except the checks, were planted in unreplicated single-row plots.

Four check varieties, Kinandang Puti, Fortuna, Apostol, and Raminad Strain 3 were included in every twentieth row. Two or three 10-day-old seedlings were planted to a hill. The distance between hills was 20 centimeters. The rows were 2.5 meters long and were spaced 40 centimeters apart. Two weeks after planting, each hill was thinned to one plant.

Kinandang Puti and Fortuna are early upland varieties. Apostol and Raminad Strain 3 are medium early and medium late lowland varieties, respectively, when planted during the regular wet season (about July). However, both behave as late varieties when planted early, and as early varieties when planted late.

Three characters, days from planting to heading, plant height, and number of tillers, were studied. *Days to heading* was the period from planting to 50 per cent heading of each variety. *Plant height* was the distance from ground level to the tip of the panicle (excluding awns, if any) of the tallest tiller of a representative plant of a variety. *Number of tillers* referred to those tillers bearing mature panicles at harvest time.

RESULTS AND DISCUSSION

Check varieties. The performances of the three check varieties, Kinandang Puti, Fortuna, and Apostol, were studied for the first five planting dates to provide information on the influence of environmental conditions in different parts of the experimental field on the three characters (tables 1a and 1b). Because of a number of missing data for Raminad Strain 3, this variety was excluded from the analysis. The data for February planting were also not considered owing to extreme variability in heading dates of the

TABLE 1a.—*Mean days to heading, plant height, and number of tillers of the check varieties in bimonthly plantings*

CHARACTER	VARIETY	PLANTING DATES					MEAN
		Mar. 29	June 2	Aug. 1	Oct. 5	Dec. 7	
Days to heading	K. Puti	81.5	78.1	82.9	86.5	87.8	83.4
	Fortuna	90.4	89.1	85.9	97.9	101.1	92.9
	Apostol	191.8	161.8	87.5	65.0	62.9	113.5
	Mean	121.2	109.7	85.0	83.1	83.9	
Plant height (cm.)	K. Puti	143.1	142.1	129.8	120.5	115.5	130.2
	Fortuna	143.5	160.1	141.2	148.1	138.4	146.3
	Apostol	189.8	186.9	160.6	107.4	109.0	150.7
	Mean	158.8	163.0	143.9	125.3	121.0	
No. of tillers	K. Puti	10.1	8.0	8.2	9.2	6.9	8.5
	Fortuna	7.1	7.5	9.9	6.8	6.8	7.6
	Apostol	13.8	12.5	13.6	16.2	13.5	13.9
	Mean	10.3	9.3	10.6	10.7	9.1	

TABLE 1b.—*Mean squares for days to heading, plant height, number of tillers and interactions of check varieties in bimonthly plantings*

VARIANCE SOURCE	D.F.	MEAN SQUARES		
		Days to heading	Plant height (cm.)	No. of tillers
Planting dates	4	7519.86 **	8687.74 **	13.98
Replicates	7	22.84	235.98	20.19 **
Error a	28	26.66	140.90	5.24
Varieties	2	11584.36	4663.22	473.25 **
Varieties × dates	8	10515.19 **	3114.36 **	12.98 *
Varieties × replicates	14	17.78	135.95	6.61
Error b	56	13.77	122.14	5.38
Total	119			

tillers from the same plants of certain varieties. Perhaps the relatively shorter days and longer nights at this time of the year induced earlier flower-bud formation on early tillers but not on late ones (Jodon, 1953; Manuel and Velasco, 1957).

If the checks behave similarly in different replicates, it could be assumed that the experimental field was reasonably homogeneous and, therefore, all varieties could be compared with respect to the

trait or traits under study. The non-significant variances for replicates and varieties × replicates interaction for both days to heading and plant height are indications of soil uniformity. Relationships could therefore be established between these two traits or between these traits and their respective annual ranges.

The non-significant varieties × replicates interaction for number of tillers shows that the varieties behaved similarly in different replicates, but the highly significant variance for replicates indicates that the soil in the experimental area differed sufficiently to affect tiller number. Although it would appear that reliable relationships could be established between tiller number and either of the other two traits, or between tiller number and its annual range for the checks, it might be possible that certain varieties with different tillering capacities and located in different portions of the field could behave differently with respect to this trait. For this reason, the data on tiller number of the varieties in the experiment were omitted.

Association between days to heading and plant height, and their respective annual ranges. The simple correlation coefficient between days to heading and plant height of the varieties was determined for each planting date to study the possibility of predicting the relative value of one character from a study of the other. All correlation coefficients were positive and significant, that is, the later the variety, the taller it was (table 2). The degrees of relationship sub-

TABLE 2.—*Correlation coefficients between days to heading and plant height and between these traits with their respective annual ranges in bimonthly plantings*

PLANTING DATE [a]	CORRELATION COEFFICIENTS (*r*)		
	Heading & range	Height & range	Heading & height
(1) March 29	.970 *	.581 *	.715 *
(2) June 2	.279 *	.553 *	.676 *
(3) August 1	.439 *	.775 *	.498 *
(4) October 5	−.342 *	−.475 *	.771 *
(5) December 7	−.314 *	−.470 *	.650 *

[a] 251 varieties were used for the first four plantings and 248 for the last one.
* Significant at 5 per cent level or less.

stantiated previous findings (Vibar, 1921). Differences among correlation coefficients were significant except those between planting date 1 and dates 2, 4, and 5, and between dates 2 and 5. None of the coefficients, however, was sufficiently high to enable one to select in-

directly for one character by selecting directly for the other. The results of this study indicate that direct selection for both characters should be practiced to attain the desired goals in breeding programs.

The correlation coefficients between days to heading and plant height, and their respective annual ranges were also determined for each planting date to study the possibility of predicting from a single trial the relative performance of the varieties when planted the year round. All correlation coefficients were significant and positive for the March, June, and August plantings but negative for the October and December trials. Differences among pairs of r's for plant height were significant except those between dates 1 and 2 and between dates 4 and 5. Like the association between heading and height, none of the coefficients for plant height seemed sufficiently large for prediction purposes. For days to heading, there were no significant differences among pairs of r's having like signs, except that between dates 1 and 2 which was significant. The degree of relationship for the March planting ($r = .970$) was sufficiently high for prediction purposes. The positive relationships mean that if a variety is late and tall when planted early in the season (March to August), it will also have a wide annual range in both days to heading and height. The negative coefficients for both traits obtained during the later-season plantings indicate that an early and short variety will likely have wider annual ranges in both days to heading and height. Therefore, such varieties are seasonal. From the grower's standpoint, the non-seasonal varieties are more desirable because grain yields seem to be less affected by season of planting (Abesamis, 1922; Gotera, 1930; Calma and Palis, 1948; Calma and Piga, 1948; Calma and Aberion, 1951; Umali and Tepora, 1955), provided other factors affecting yield are kept reasonably similar in all plantings.

Association in March planting of days to heading with its annual range. The high correlation in March planting of days to heading with its annual range may be taken as a basis for predicting the flowering response of varieties to season of planting. To have an idea of the magnitudes of variation in annual ranges of days to heading over the entire range of maturities, the varieties were divided into six maturity groups of at least 20 days range each and the coefficients of variation computed for each group (table 3). In general, the coefficients of variation of the mean annual ranges in heading of the three early groups were four to five times greater than those of the three late groups, indicating that the seasonal re-

actions of varieties within the former groups were less consistent than those within the latter groups. Consequently, predictions regarding the seasonal response of early varieties may not be as reliable as those for the late ones.

TABLE 3.—*Days to heading and its annual range, their coefficients of variation and regression coefficient of annual range on days to heading for each maturity group in March planting*

MATURITY GROUP	RANGE IN DAYS TO HEADING	NO OF VARIETIES	MEAN DAYS TO HEADING	C.V. (%)	MEAN ANNUAL RANGE	C.V. (%)	b RANGE-HEADING
Extra Early	95 or less	97	85.4	8.6	14.9	40.3	.195 *
Early	96–115	48	105.1	5.4	22.2	53.6	.223 *
Medium Early	116–135	20	124.4	5.0	43.5	40.5	1.770 *
Medium Late	136–155	19	145.0	3.3	74.8	9.3	.057
Late	156–175	9	169.6	3.1	95.7	12.9	.864 *
Extra Late	Over 175	58	203.9	8.2	124.3	8.6	.478 *
All Varieties	—	251	127.17	37.91	51.31	89.86	.9281 *

* Significant at 5 per cent level or less.

The regression coefficients of annual ranges in heading on days to heading for the maturity groups were all significant except that for the medium late group. Perhaps more observations are needed to establish the significance of the regression value, which was rather low for this group. The regression equation of annual range in heading on days to heading of any variety within each maturity group can be expressed as:

$$\hat{R} = \bar{R} + b(D.H. - \overline{D.H.})$$

where

$\hat{R}$ = estimated annual range in heading of a variety,

$\bar{R}$ = mean annual range in heading of the maturity group,

b = regression coefficient of annual range in heading on days to heading,

$D.H.$ = days to heading of the variety, and

$\overline{D.H.}$ = mean days to heading of the maturity group.

The flowering response of varieties may be divided for convenience into three categories according to annual ranges in days to heading. If varieties with annual ranges of four weeks or less are considered weakly, those with four to eleven weeks, moderately, and those with greater than eleven weeks, strongly seasonal, the two

early groups will fall into the first category, the two medium groups into the second and the two late groups into the third. By planting varieties in March, it is possible to classify them into any of the six maturity groups, and, therefore, into any of the three categories of flowering response. Knowledge of the relationship of seasonal behavior to length of maturity is particularly helpful to rice breeders handling enormous numbers of breeding materials, since they are usually confronted with the problem of evaluation for seasonal reaction.

Flowering behavior of varieties planted at different dates. The mean days to heading and its coefficient of variation were studied for each planting date to determine the pattern of flowering response of varieties within each maturity group (table 4 and fig. 1). In general, the coefficients of variation fall within acceptable

TABLE 4.—*Mean days to heading and its coefficient of variation for each maturity group and planting date*

MATURITY GROUP	NO. OF VARIETIES	MARCH 29		JUNE 2		AUGUST 1		OCTOBER 5		DECEMBER 7	
		Mean	C.V.	Mean	C.V.	Mean	C.V.	Mean	C.V.	Mean	C.V.
			per cent		*per cent*		*per cent*		*per cent*		*per cent*
Extra Early	97	85.4	8.6	81.6	11.1	80.2	11.7	85.2	14.1	87.4	15.1
Early	48	105.1	5.4	97.6	9.1	86.8	11.0	92.0	15.7	94.5	20.0
Medium Early	20	124.4	5.0	106.4	8.8	86.4	14.6	87.7	20.3	88.3	22.2
Medium Late	19	145.0	3.3	102.3	7.1	79.8	7.6	71.5	10.6	71.9	13.2
Late	9	169.6	3.1	117.7	6.7	84.0	7.3	75.1	7.5	74.1	8.8
Extra Late	58	203.9	8.2	142.8	11.4	99.3	14.5	80.6	14.5	85.2	21.0

limits (3.1 to 22.2 per cent), particularly with the early and regular season plantings, indicating that varieties within groups behaved similarly when planted the year round. The reduction in days to heading due to lateness of planting was greatest with the extra lates and least with the extra earlies. This trend is also indicated in a previous study on 46 rice varieties of different origin (Velasco and De la Fuente, 1958). The minimum days to heading of the three early and the three late groups were attained in the August and October plantings, respectively. From then until December, the varieties tended to head slightly later with lateness of planting, perhaps on account of cooler temperature at this time of the year (Oka *et al.*, 1952).

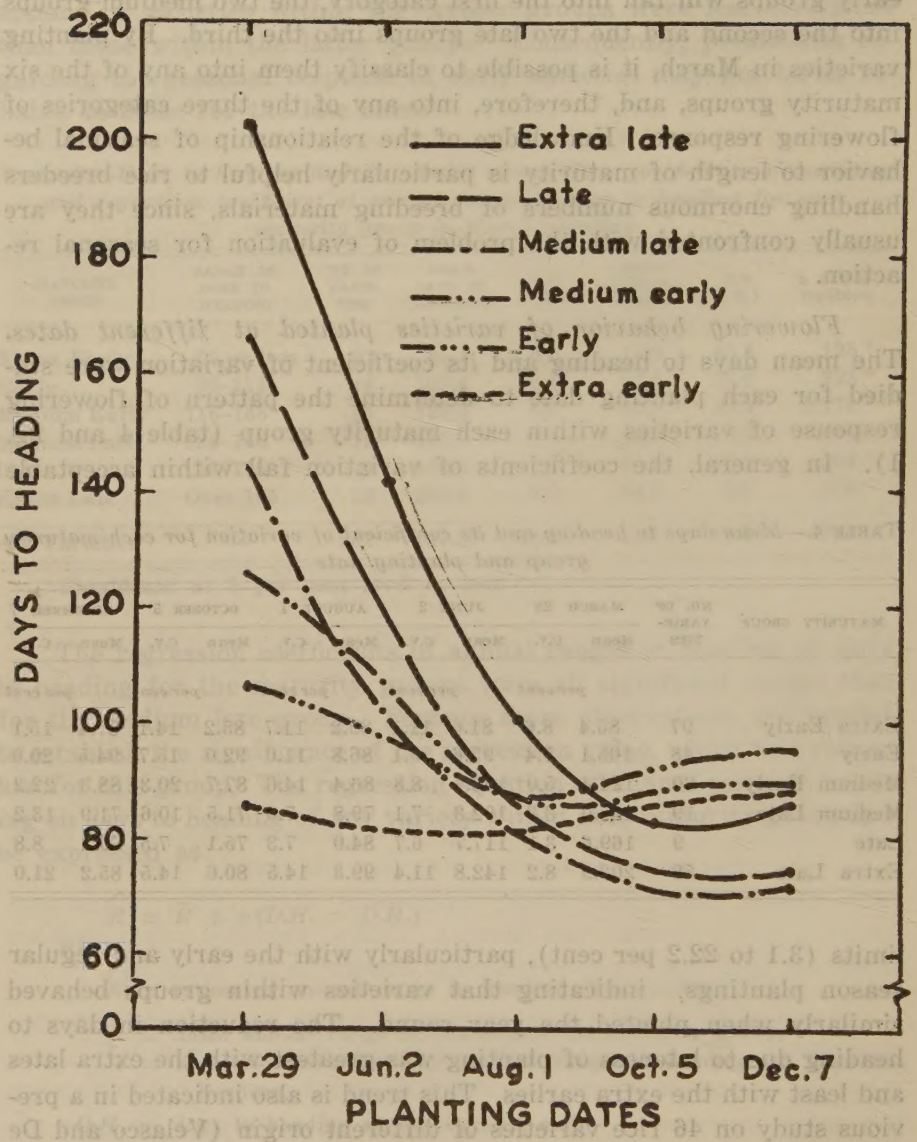

Fig. 1.—Mean days to heading for each maturity group and planting date.

If day-length and temperature are climatic factors primarily affecting the seasonal reaction of varieties (Oka *et al.*, 1952), then under the conditions of this study (fig. 2) or similar ones, the days to heading of any variety previously classified into any maturity

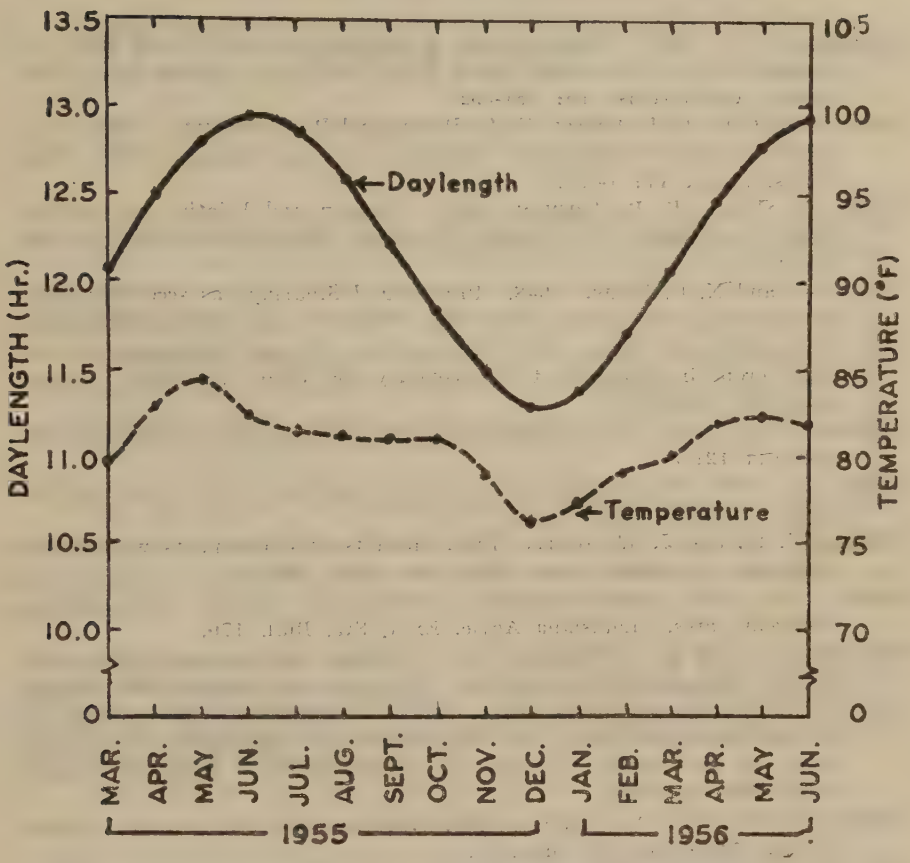

Fig. 2.—Mean monthly day lengths and temperatures (March, 1955 to June, 1956).

group when planted at any time between March and December, may be approximated with the use of the curves for heading dates (fig. 1). For example, if a late variety is planted in August, it will have similar days to heading as an extra early variety planted in March and may be expected to head about 84 days after planting. The actual days to heading will, on the average, fall within 7 per cent of 84 days (table 4). The curves for the late and extra late groups, but not for the other groups, may be used further to include unclassified varieties, provided days to heading from any planting between March and June is available and falls within the approximate limits of the two curves.

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CHROMOSOME NUMBER AND FERTILITY TESTS IN BOUGAINVILLEA [1]

JUAN V. PANCHO, JOSÉ M. CAPINPIN and ELISEO A. BARDENAS

WITH TWENTY TEXT FIGURES

Chromosome numbers for 30 horticultural varieties including one species of *Bougainvillea* based on meiotic and somatic observations seemed to indicate that 17 is the basic number of this genus. Five tetraploids and three triploids have been discovered.

Results of intraspecific hybridization tend to show that there was no significant sterility barrier between hybrids derived from parents of different chromosome numbers. The resultant hybrids gave high pollen fertility and in some cases produced viable seeds on selfing.

With the current enthusiasm shown by both amateur and professional floriculturists in *Bougainvillea,* taxonomic, cytogenetic, and physiological problems have received the attention of plant researchers.

Subsequent to the taxonomic investigations of this genus conducted by Pancho and Bardenas (1959), a cytological study was initiated to determine the possibilities of crossing various horticultural forms and varieties.

MATERIALS AND METHODS

The materials for chromosome studies were obtained from the root tips of potted plants.[2] The severed root-tips were pretreated one to four hours in a saturated aqueous solution of paradichlorobenzene. Killing and fixation were accomplished by an overnight treatment with Carnoy's solution. The roots were then treated in 10 per cent HCl for ten to thirty minutes and rinsed in water. The tip portion was transferred to a drop of 45 per cent acetic acid on a slide, smeared, and stained in aceto-orcein. As a check on the manner of pairing of chromosomes, examinations of the microsporocytes were made according to the technique of Smith (1947).

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[1] Central Experiment Station Contribution No. 2038.

[2] All Bougainvillea cultivars studied in this work are in cultures at the Department of Agricultural Botany.

Chromosome configuration was studied during stages of diakinesis. Camera lucida drawings were made at a magnification of about 3500. Herbarium specimens of the specific plants from which counts were made in this study are filed at the College of Agriculture Herbarium, University of the Philippines, College, Laguna.

RESULTS AND DISCUSSION

Chromosome counts. The data obtained from an examination of both somatic tissues and the meiotic phase from pollen mother cells (PMC), including those chromosome counts recorded in the literature, are presented in table 1. Counts determined in this study are distinguished by an asterisk (*). The haploid number of 17 reported in some horticultural varieties (Wilson, 1947) is confirmed.

Meiotic figures of all PMC smears studied appeared normal (fig. 6, 8, 9, 10, 14, 15 and 17) except in cultivars derived from *B.* × *Buttiana.*

The most common meiotic abnormality was the formation of rings and chains of from 3 to 5 chromosomes during diakinesis (fig. 4). The second most observed abnormality was lagging univalents and bivalents during metaphase (fig. 2 and 3). During anaphase and early telophase I, chromatid bridges without fragments (fused chromatids) (fig. 1) and lagging chromosomes were observed. Several figures contained multiple bridges (fig. 5).

Lagging was observed during metaphase and early telophase. Bridge fragments and "fused chromatids" were also formed. This phenomenon is associated with lack of chromosome homology. Lagging bivalents may be caused by certain internal factors that upset the spindle mechanism and terminalizations' timing relations (Stebbins, 1945). Fused chromatids may be caused by non-disjunctions of one or more pairs of homologues and the persistent association of distal ends of homologous chromatids (Sax, 1932).

Wilson's (1947) assumption "that the horticultural varieties of *Bougainvillea* are amphidiploids and that a species (*B. spectabilis*?) with a basic number of X = 7 should exist" and that of Cooper (1931) who reported 2n = 20 in certain species of *B. glabra* have not been confirmed in this investigation. Of the four horticultural varieties of *B. spectabilis,* none exhibited a haploid number of 7. It may be assumed, tentatively, on the basis of the present findings that the Philippine horticultural varieties of *Bougainvillea* have a basic chromosome number of 17.

TABLE 1.—*Chromosome numbers in Bougainvillea*

TAXON	SOMATIC CHROMOSOME NUMBER	INVESTIGATOR
B. × *Buttiana*		
* cv. 'Mrs. Butt'	34, 68	
* cv. 'Crimson King'	68	
* cv. 'Golden Glow'	34	
* cv. 'Louis Wathen'	34	
* cv. 'Mrs. McLean'	34	
* cv. 'Pigeon Blood'	34	
* cv. 'Princess Mahara"	68	
* cv. 'Scarlet Queen'	34	
B. glabra	20	Cooper, 1931
* cv. 'Bois de Rose'	34	
* cv. 'Cypheri'	51	
cv. 'Dark Purple'	34	Wilson, 1947
cv. 'Formosa'	34	Wilson, 1947
* cv. 'Formosa'	34	
* cv. 'Khaki'	34	
* cv. 'Lady Huggins'	34	
* cv. 'Magnifica'	68	
* cv. 'Mrs. Leaño'	34	
* cv. 'Mrs. Magsaysay'	34	
* cv. 'Miss Manila'	34	
* cv. 'Penang'	34	
* cv. 'Philam Beauty'	34	
* cv. 'Pink Beauty'	34	
* cv. 'Polka Dots'	34	
* cv. 'Rainbow'	34	
* cv. 'Snow White'	34	
* cv. 'Temple Fire'	34	
* cv. 'Texas Dawn'	34, 51	
* cv. 'Variegata'	34	
* *B. peruviana*	34	
B. spectabilis		
cv. 'Crimson Lake'	20	Cooper, 1931
* cv. 'Lateritia'	51	
* cv. 'Luisa'	34	
cv. 'Orange King'	34	Wilson, 1947
cv. 'Ruby'	34	Wilson, 1947
cv. 'Royal Purple'	34	Wilson, 1947
* cv. 'Speciosa'	34	
* cv. 'Thomasii'	34, 68	

* Somatic counts of cultivars preceded by asterisk are reported by the present authors.

EXPLANATION OF FIGURES 1-19

Fig. 1-19.—Chromosomes in *Bougainvillea*. Fig. 1-5.—Microsporogenesis in *B.* 'Mrs. Butt': fig. 1, chromatid bridges (fused chromatids), anaphase II; fig. 2, lagging bivalent, metaphase I; fig. 3, lagging chromosomes, early telophase

I; fig. 4, 15 bivalents and circle of four chromosomes ("figure eight"), diakinesis; fig. 5, muitiple chromatid bridges, early telophase I. Fig. 6. Telophase I in *B.* 'Tomasii' with 17:17 distribution of chromosomes. Fig. 7. Metaphase I in *B.* 'Pigeon Blood' showing several quadrivalents and bivalents. Fig. 8. Prometaphase I in *B.* 'Pink Beauty' with 17 bivalents. Fig. 9. Diakinesis in *B.* 'Texas Dawn' with 17 bivalents. Fig. 10. Telophase I in *B.* 'Lady Huggins' with 17:17 distribution of chromosomes. Fig. 11. *B.* 'Bois de Rose', 2n = 34 (side view). Fig. 12. *B.* 'Penang', 2n = 34. Fig. 13. *B.* 'Speciosa', 2n = 34. Fig. 14. Prometaphase I in *B.* 'Formosa' with 17 bivalents. Fig. 15. Meiotic metaphase in *B.* 'Scarlet Queen' with 17 pairs of chromosomes. Fig. 16. *B.* 'Miss Manila', 2n = 34. Fig. 17. Telophase I in *B.* 'Temple Fire' with 17:17 distribution of chromosomes. Lig. 18. *B.* 'Snow White', 2n = 34. Fig. 19. *B.* 'Rainbow', 2n = 34 (side view)

It is significant that somatic counts of 68 chromosomes were revealed in five forms, namely, *B.* × *Buttiana* cvs. 'Mrs. Butt', 'Crimson King', 'Princess Mahara', *B. glabra* cv. 'Magnifica' and *B. spectabilis* cv. 'Thomasii'. If it is assumed that 17 is the basic number, these cultivars would represent tetraploid form. On the other hand, three cvs. 'Texas Dawn', 'Cypheri' and 'Lateritia' exhibited 51 chromosomes indicating a triploid form. Tetraploidy may have arisen from either the natural doubling of the somatic chromosomes of 34 to form a cultivar with 68 chromosomes or from the fusion of both unreduced pollen and ovule gametes, each carrying 34 chromosomes, to form a zygote with 68 chromosomes. Triploidy, on the other hand, is generally the resultant of unreduced gamete with 34 chromosomes fusing with a reduced one with 17 chromosomes to produce a zygote with 51 chromosomes. In living materials these cytotypes exhibit morphological characteristics which are mostly admired by horticultural fanciers (fig. 20). Likewise they exhibited cytogenetic behavior characteristic of these forms when crossed with the corresponding diploid forms.

Fertility tests. Although the hybridization program has not been completed, it would be of interest to report some of the results so far obtained. At present over 50 attempts at crossing have yielded 20 F_1 hybrids. This rather low number of successful hybridization, however, may not be taken as a true estimate of crossability or cross fertility tests. The mechanical difficulties in making controlled emasculations and insect-free pollinations greatly impaired the accuracy of estimates of crossabliity.

Crosses have been made between cultivars of the same or different chromosome numbers. Table 2 summarizes the information derived from some of these crosses. On the basis of pollen fertility, indicated by differential staining of microspores with anilin-lacto-

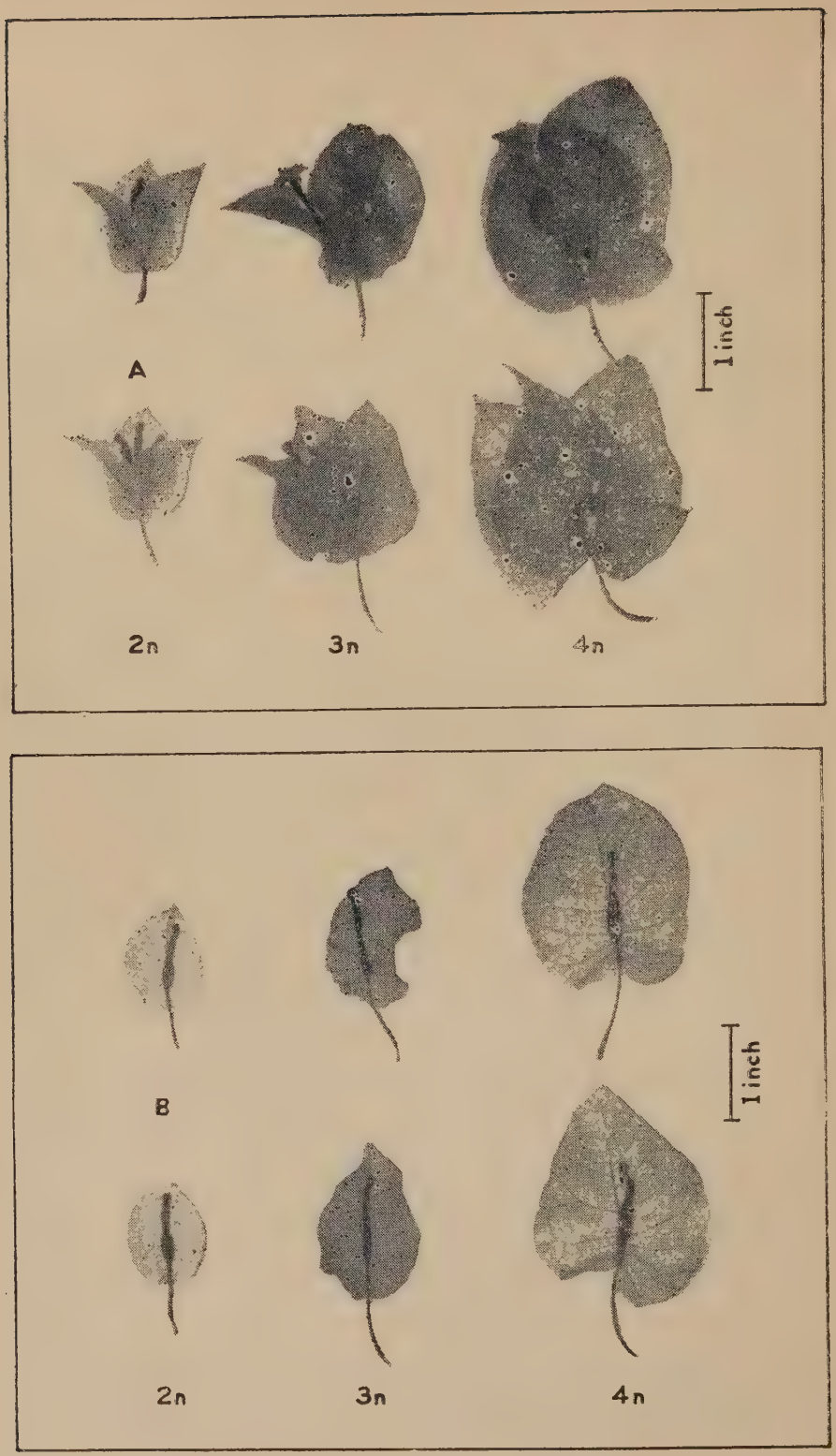

Fig. 20.—Relationship between floral parts and chromosome number in *Bougainvillea*, in which the basic number is 17. A—whole flower of each cytotype; B—Floral part of each cytotype.

TABLE 2.—*Results of hybridization in Bougainvillea*

INTRASPECIFIC HYBRID	CHROMOSOME NUMBERS OF PARENTS	PER CENT OF POLLEN FERTILITY	MEIOTIC BEHAVIOR	
			Pairing and Univalents	Tetrads
'Sanderiana' × 'Pink Beauty'	34 × 34	95	17 pairs, no laggards	Normal
'Golden Glow' × 'Rainbow'	34 × 34	95	17 pairs, no laggards	Normal
'Speciosa' × 'Penang'	34 × 34	90	17 pairs, rarely 1-2 univalents	Normal
'Spectabilis' × 'Texas Dawn'	34 × 34	85	Mostly 17 pairs, but occasional laggards	Normal
'Sanderiana' × 'Snow White'	34 × 34	95	17 pairs, no univalents	Normal
'Penang' × 'Formosa'	34 × 34	95	17 pairs, no laggards	Normal
'Mrs. Butt' × 'Sanderiana'	34 × 34	90	17 pairs, rarely 1-2 univalents	Normal
'Mrs. McLean' × 'Formosa'	34 × 34	85	Mostly 17 pairs, but occasional laggards	Normal
'Snow White' × 'Cypheri'	51 × 34	90	Variable: univalents & bivalents variable	4-spored with micro-nuclei
'Pink Beauty' × 'Mrs. Butt'	34 × 34	90	17 pairs, no laggards	Normal
'Lady Huggins' × 'Bois de Rose'	34 × 34	95	Usually 17 pairs, rarely 1-2 univalents	Normal
'Magnifica' × 'Snow White'	68 × 34	60	Less than 30 pairs, numerous lagging univalents	4-spored with micro-nuclei
'Lateritia' × 'Penang'	51 × 34	90	Possibly few lagging univalents	Normal

phenol, and meiotic behavior of the hybrids, it appears possible that there may be no significant environmental or genetic sterility barriers among intraspecific taxa. Even the hybrids derived from parents of different numbers gave high pollen fertility and in some cases set viable seeds on selfing.[3] The cross between tetraploid 'Magnifica' and diploid 'Snow White' is a good example. It has produced progeny when backcrossed to both parents. It is hoped that further investigation will reveal the nature and extent of intraspecific compatibility and taxon affinity in *Bougainvillea*.

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[3] Grateful acknowledgment is due Mr. B. Leaño of Quezon City, for furnishing the authors some data on hybridization.

TRIPLE FORMULATOR AND LEAST-COST RATIONS FOR GROWING-FINISHING PIGS[1]

J. A. Eusebio, R. B. Puyaoan, E. C. Cruz, and B. F. Llorico

WITH FOUR TEXT FIGURES

Data from twelve feeding experiments involving 222 pig observations were used in the calculation of the prediction equation for the triple formulator and least-cost swine ration. The equation for predicting the F/G is $\hat{Y} = 70.0647 - .44249X_1 - 1.03075X_2 - 1.03950X_3 + .04539X_4$ wherein X_1 stands for the level of rice bran; X_2, corn; X_3, copra meal and X_4, pig weight. In testing the theory, the observed values compared to the predicted values showed no significant difference ($P>.05$).

As a guide for practical hog feeding, three triangular formulators were developed. The lowest-cost rations can be achieved by varying the different levels of the feed ingredients based on their relative changes in price.

Feed costs represent approximately 80 per cent of the total cost of hog production. Thus the hog raisers' chance to reduce the costs of pork production will depend largely upon their ability to reduce feed costs.

Since the price of butcher pigs in the market remains relatively constant, the amount of feed required to produce a kilogram gain and the relative prices of different feedstuffs determine profit.

The cheaper and more common feed ingredients for growing pigs are rice bran, corn, and copra meal. Fish meal is higher in feeding value but comparatively more expensive than other locally available feed ingredients for swine. Very few farmers can afford to include fish meal in the rations, especially for growing-finishing pigs.

Carton *et al.* (1954) and Catron (1955) developed the "least-cost" and "least-time" rations based on corn-soybean oil meal fortified with minerals, vitamins and antibiotics. The application of the theory was put into effect in the scientific circular slide rule-Pork Costulator for calculating the most profitable growing-finishing hog ration.

[1] Central Experiment Station Contribution No. 2039.

This study, with the application of the prediction equation, was also designed to formulate simple ration and enable farmers to apply the "least-cost" ration principle in swine feeding.

SOURCE AND CLASSIFICATION OF DATA

The data used in this study were obtained from twelve swine feeding experiments in the University of the Philippines, College of Agriculture and Central Experiment Station, College, Laguna, compiled from 1955 to 1958, inclusive. The experimental data involved 222 pig observations on group-fed growing pigs.

The type of experiment used in this study varies but the general management practices were relatively similar. The experimental rations used include fish meal which was eliminated in the proposed simple formulator and corrected for total digestible nutrients and crude protein by proportion.

The pigs used in these feeding experiments were all of Berkjala breed. The feeding periods were carried from 10 to 80 kilograms liveweight of growing pigs. Age and sex were ignored in the analysis of the data. Hays *et al.* (1958) found that age and sex are less correlated to growth performance in nutrition studies of swine.

It is also wise to call attention to the treatment effects which were excluded because the data were obtained purely on the control lot.

EXPERIMENTAL PROCEDURE

Methods of analysis. The calculation required to fit a multiple linear regression was based on the work of Snedecor (1956) and Cochran and Cox (1957). The multiple regression equation can be written in this general model:

$$Y = a + b_1X_1 + b_2X_2 + b_3X_3 + \ldots + b_kX_k$$

where a, b_1, b_2, b_3, . . . b_k are parameters which are to be estimated.

It is beyond the scope of this paper to give a detailed description of the method of least squares to fit a multiple regression of yu on the k variables, xiu ($i = 1,2 \ldots k$, $u = 1,2, \ldots n$), but a brief process can be demonstrated. Four regression coefficients are calculated by solving simultaneously the normal equations which are similar to the normal equation of simple correlation:

$$Na + b_1SX_1 + b_2SX_2 + b_3SX_3 + b_4SX_4 = SY$$
$$aSX_1 + b_1S(X_1^2) + b_2S(X_1X_2) + b_3S(X_1X_3) + b_4S(X_1X_4) = SX_1Y$$
$$aSX_2 + b_1S(X_1X_2) + b_2S(X_2^2) + b_3S(X_2X_3) + b_4S(X_2X_4) = SX_2Y$$
$$aSX_3 + b_1S(X_1X_3) + b_2S(X_2X_3) + b_3S(X_3^2) + b_4S(X_3X_4) = SX_3Y$$
$$aSX_4 + b_1S(X_1X_4) + b_2S(X_2X_4) + b_3S(X_3X_4) + b_4S(X_4^2) = SX_4Y$$

The values of N, SX_1, SX_2 . . . $S(X_4Y)$ are substituted in the normal equation in solving for the parameters, a, b_1, b_2, b_3, and b_4 by the usual algebraic method. The prediction equation was arrived at,

$$\hat{Y} = 70.0647 - .44249X_1 - 1.03075X_2 - 1.03950X_3 + .04539X_4$$

wherein the first three subscript-independent variables represent the levels in kilograms per 100 kilogram mixture of three ingredients, X_1, rice bran, X_2, yellow corn, X_3, copra meal; and X_4 the liveweight of the pigs in kilograms to be fed. The dependent variable, $\hat{Y}$, represents the amount of feed (kilograms) required to make a kilogram gain $(\hat{F}/G)$.

The independent variables representing the three feed ingredients affect the feed conversion efficiency indirectly. The liveweight of the pig to be fed also plays an important role in computing for the energy requirement for maintenance and growth.

In calculating for the prediction equation, the levels of the three feed stuffs are expressed in total digestible nutrients. Total crude fiber and crude protein outcome of the feed mixture greatly reflect the amount of feed required to make a kilogram gain.

To illustrate this, the increased level of rice bran increases the level of crude fiber and decreases crude protein in the mixture. Thus, an increased crude fiber and decreased crude protein substantially reflect a poorer digestible nutrient content of the ration, in which case more feed would be required to compensate for the nutritive requirement for growth. Maynard and Loosli (1956) stated that increased physiological efficiency (tissue formation or growth) resulted from high nutritional planes of intake. Evvard and his associates (1927) studied the effect of weight of pigs on the feed required to produce a unit of gain. They found that pigs with a higher initial weight required more feed per unit of gain because the average weight and average maintenance requirement during their feeding period are greater.

RESULTS AND DISCUSSION

Theoretical equation applied to feeding. Four randomly chosen feed mixtures were used in studying the deviations of the actual feed conversion efficiency (F/G), from the mean theoretical values $(\hat{F/G})$ derived from the prediction equation. A total of 32 growing pigs were used in the feeding trials. Eight growers weighing from 20 to 35 kilograms, fed in groups of two for each feed mixture, were observed for every 44-day feeding period.

The observed F/G (feed required per unit gain) in actual feeding as compared to the means of the theoretical feed conversion to make a unit gain were insignificant (fig. 1). This simply shows

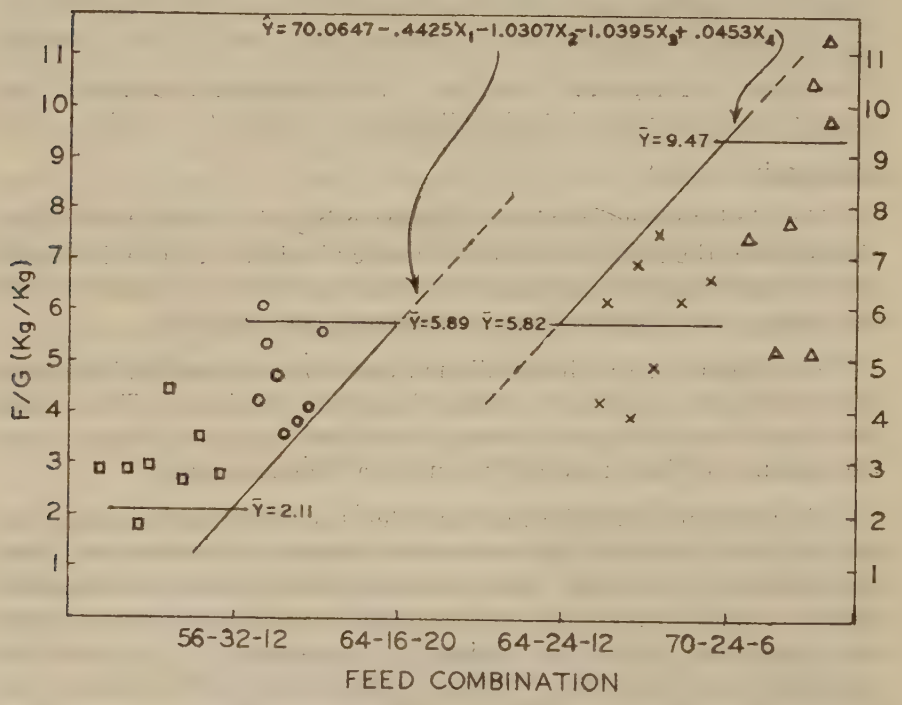

Fig. 1.—Departure of observed F/G from theoretical mean values $(\hat{F/G})$. Legend: □, 56-32-12; 0, 64-16-20; x, 64-24-12; Δ, 70-24, 6).

that actual feeding practice using either on of the 72 feed mixture combinations will yield on the average a close estimate on the predicted value of the equation without significant differences.

For instance, the 64-16-20 mixture (rice bran-corn-copra meal, parts by weight in every 100 kilograms) when fed actually to eight growing pigs weighing from 25 to 40 kilograms, obtained an average of 4.18 kilograms of feed to produce a kilogram gain. The theoretical mean value of this particular feed mixture shows an $\hat{F}/G$ of 5.82 which is even much higher than the observed F/G. The individual observed feeding conversion efficiency of the pigs was statistically differentiated from the mean value of the equation and obtained a non-significant departure from linearity ($P>.05$).

Results from the other three selected feed mixtures when compared to the corresponding theoretical mean values revealed no significant differences ($P>.05$).

Nutritional evaluation and growth requirement. The nutritional needs at any period during growth are determined by the rate of gain expected and the average body weight during the period in question. Body weight provides the basis for arriving at the nutritional requirement (or energy) for basal metabolism and activity. The total calorie requirement obtained for basal metabolism, activity, and growth tissue formed is the estimated net energy requirement which can be in the form of metabolizable energy less SDA ("Specific Dynamic Action") or total digestible nutrients (TDN) by applying factors as described by Brody (1945). One gram of TDN is estimated to be roughly equivalent to four calories.

In the calculated analyses of the four rations used to evaluate the nutritional requirements for growth, the total digestible nutrients ranges from 71.61 to 72.79 kilograms (table 1). According to this table, if a 40 kilogram pig is fed with a ration mixture of 56-32-12, the theoretical amount of feed required to make a gain is 2.11 kilograms. This value is exceptionally low and may be considered an efficient feed combination. It also appears to be a critical value when compared to the feed conversion efficiency obtained from average feeding experiments. However, it should be borne in mind that young pigs are the most efficient feed converters into liveweight gain (Bywater and William, 1936).

Based on the feeding standards for maintenance requirement computed from the equation $Y = AM^{0.73}$ (Brody 1945), in which Y represents TDN and M for body weight, the energy maintenance expressed in total digestible nutrients for pigs weighing 40 kilograms is 0.523 kilogram. On the basis of the calculated analysis, the TDN

contained in 2.11 kilograms (predicted value) is 1.53 kilograms. Thus, the presupposed amount of TDN for growth requirement is equivalent to 1.01 kilogram. This value for growth requirement is even higher than what had been expected. Moreover, the doubts on this theory have been checked by the actual feeding trial mentioned in the previous discussion.

TABLE 1.—*Nutritional analyses of the ration mixtures*

ANIMAL LIVE-WEIGHT	MIXTURES RB-C-CM	THEORETICAL F/G	TOTAL CRUDE FIBER	TOTAL CRUDE PROTEIN	TOTAL DIGESTIBLE NUTRIENTS				
					Ration	Theo. F/G	Theo. F/G	Maint.[a]	Growth req.
(*kg.*)			*per cent*	*per cent*	(*kg./100*)	(*kg.*)	*per cent*	(*kg.*)	(*kg.*)
40	56–32–12	2.11	8.94	12.20	72.79	1.53	72.50	.523	1.01
40	64–24–12	5.89	9.77	12.37	72.19	4.25	72.16	.523	3.75
40	64–16–20	5.82	10.27	13.29	71.76	4.18	71.82	.523	3.66
40	70–24–6	9.47	10.00	11.82	71.61	6.78	71.60	.523	6.26
70	56–32–12	3.90	8.94	12.20	72.79	2.84	72.82	.783	2.06
70	64–24–12	8.01	9.77	12.37	72.19	5.78	72.16	.783	5.00
70	64–16–20	7.94	10.27	13.29	71.76	5.70	71.79	.783	4.92
70	70–24–6	11.59	10.00	11.82	71.61	8.30	71.61	.783	7.52
90	56–32–12	4.38	8.94	12.20	72.79	3.18	72.60	.943	2.24
90	64–24–12	9.08	9.77	12.37	72.19	6.55	72.14	.943	5.61
90	64–16–20	9.01	10.27	13.29	71.76	6.47	71.81	.943	5.53
90	70–24–6	12.66	10.00	11.82	71.61	9.07	71.64	.943	9.03

[a] Based on the data of Brody, Samuel. Feeding Standards for Maintenance. Bioenergetics and Growth. p. 478. 1945.

Application and evaluation of least cost ration. It is felt that the prediction equation for the "least cost" ration will be of practical value to farmers if expressed in a simple swine ration formulator.

In order to provide an easy means of calculating the hog feeding profit, the authors devised the triple formulator (fig. 2,3,4), an equivalent to the pork costulator of Catron *et al.* (1954).

Based on this triple formulator, the lowest cost ration to determine the most profit will depend upon the change in price of rice bran, corn, and copra meal. The feed conversion efficiency of a certain ration also changes as the hogs get heavier.

For example: To find the least cost ration for a 10 to 50 kilogram pig when the price per kilogram of corn is ₱0.18; copra meal, ₱0.16; rice bran, ₱0.13, select a lower corn level, say 24 kilograms.

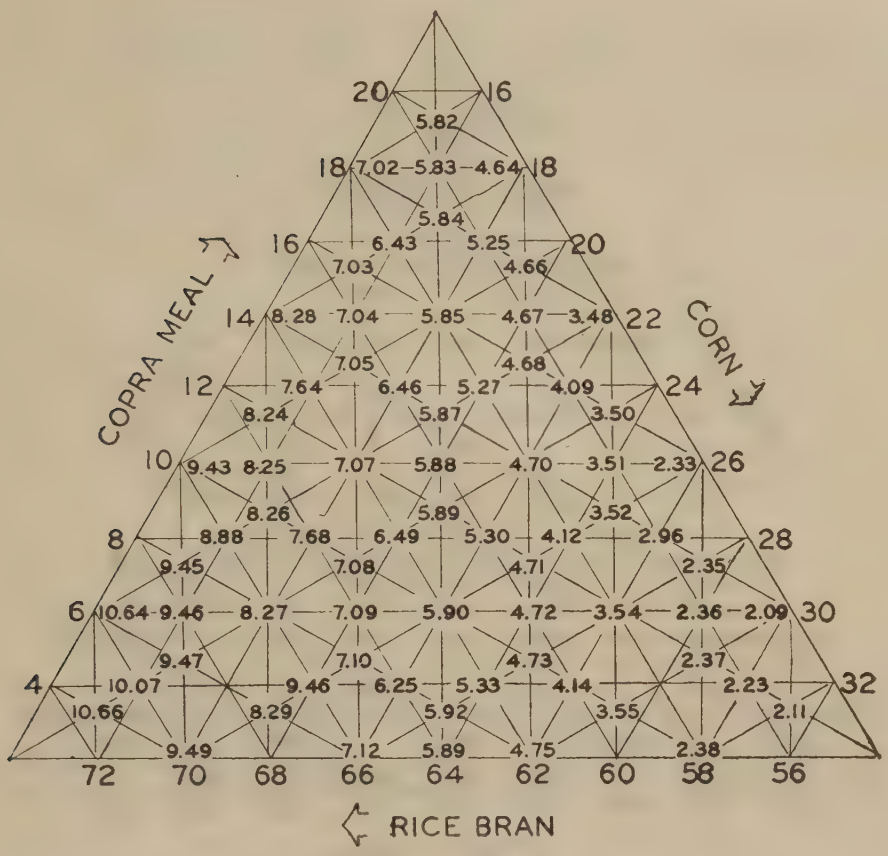

Fig. 2.—Triple formulator and least cost ration (pigs weighing 10-50 kilograms)

per 100 kilogram mixture. Then, select a level of copra meal, say 12 kilograms per 100 kilogram mixture. Take 64 kilograms, a level of rice bran to make a 100 kilogram mixture. By drawing a line perpendicular to the corresponding level-sides selected, the point of intersection will show the amount of feed required for every kilogram gain in weight, which is 5.89. This feed mixture costs ₱0.15 per kilogram as computed. Hence, a 10 kilogram pig will require 235.6 kilograms feed at ₱35.34 to attain a 50 kilogram weight.

Since feed cost represents 80 per cent of the total cost of production calculated to be ₱44.17, and the price of the 10 kilogram pig is ₱10.00, the total expenses become ₱54.17. At a selling price of ₱1.20 per kilogram liveweight, a 50 kilogram pig will sell for

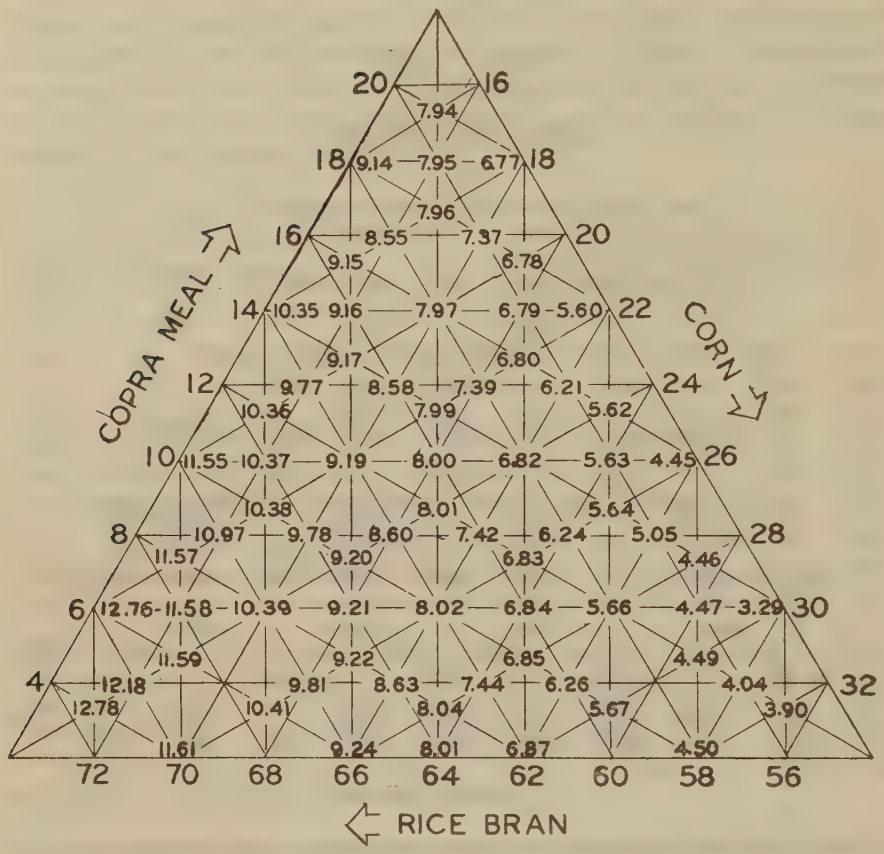

Fig. 3.—Triple formulator and least cost ration (hogs weighing 50-75 kilograms).

₱60.00. A profit of ₱5.83 is obtained. However, actual savings from feeding least-cost ration can be maximized by adjusting the ration with the relative price changes of the three major feed ingredients.

For hogs weighing more than 50 kilograms, the corresponding triple formulators are used (fig. 3 and 4). In actual feeding practice, the hog raiser should grind the corn and copra meal. Mineral supplements such as salt and ground oyster shell are included, each at one per cent of the total ration. Restricted hand feeding is recommended twice a day. Soilage should be given every day.

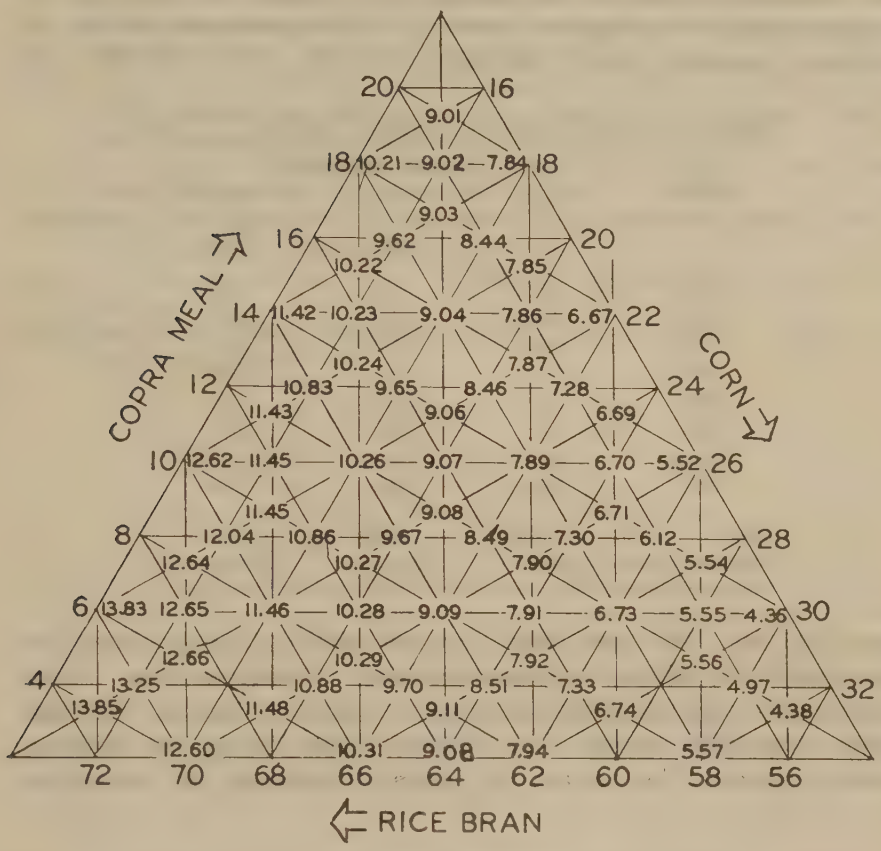

Fig. 4.—Triple formulator and least cost ration (hogs weighing 75-100 kilograms).

Effect of plane of nutrition on carcass quality. It is clear from the standpoint of the NRC requirements (1953) that protein levels of the ration outcome of the three major feed ingredients in the formulator are somewhat low. On the other hand, the fiber contents are high. However, Catron (1955) pointed out that growing-finishing hogs, regardless of weight bracket, can tolerate a relatively wide range of protein in their total ration. He further proved that pigs from 35 to 75 pounds have shown fairly satisfactory performance on rations containing from 11 to 20 per cent protein.

In the last feeding experiment, to prove the efficiency in meat production of the 70-24-6 feed combination which contains 11.82 per cent crude protein and 10 per cent crude fiber, the back-fat probe

was done at the end of the feeding period when the animals were approximately 50 kilograms (table 2). The averages of the fat thickness measured were: shoulder, 1.43 cm., loin, 1.22 cm., and

TABLE 2.—*Back fat thickness at three regions of the back*

ANIMAL NUMBER	BACK FAT THICKNESS		
	Shoulder	Loin	Ham
	(*cm.*)	(*cm.*)	(*cm.*)
753	1.5	1.4	2.0
773	1.1	1.2	1.8
70	0.9	1.0	1.5
50	1.1	1.5	2.0
769	1.0	0.6	1.8
763	2.6	2.0	2.4
751	1.0	1.3	1.8
755	2.2	0.8	2.5
Mean	1.43	1.22	1.97
Standard error	± 0.23	± 0.15	± 0.12

ham, 1.99 cm. The data show that the quality of the carcass produced still falls within the bacon standard. Crampton *et al.* (1954) claimed that restricting the feed intake of market hogs or "diluting" highly digestible rations with fibrous feeds during the finishing period, improves the carcass for bacon by reducing fat deposition.

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A COMPARISON OF LENDING POLICIES OF FACOMAS AND RURAL BANKS IN POLO AND BALIWAG, BULACAN [1]

Rusli Hakim

Two-thirds of the borrowers from the rural bank and FaCoMa were share-tenants. The size of the rural bank loans ranged from ₱30 to ₱3,300 with an average of ₱421; that of the FaCoMa loans, ₱25 to ₱420 with an average of ₱129.

All FaCoMa loans were secured with chattel mortgage, compared with 67 per cent of rural bank loans. Repayment averaged 86 per cent of the total amount due for rural banks, 70 per cent for FaCoMas.

Non-payment of loans among FaCoMa borrowers was not due to economic factors; delinquency among rural bank borrowers was economic in nature. Most of the delinquent FaCoMa borrowers were found to have enough income to repay their loans.

The government's concern for the uplift of the farmers led to the creation in 1952 of two credit agencies designed to meet their credit needs: the rural banks under R.A. No. 720 and the ACCFA (Agricultural Credit and Cooperative Financing Administration) under R.A. No. 821.

The rural banks are usually organized by private investors staying in the rural areas. These banks grant agricultural loans among others, based on the farmer's repayment capacity and secured either with real estate or chattel mortgages on crops, livestock, or implements.

The ACCFA, on the other hand, was established to organize cooperative marketing associations among small farmers. The private cooperative associations known as FaCoMas (Farmers' Cooperative Marketing Association) extend to their members loans from the ACCFA based on their marketing agreement with the cooperative.

Apparently, the ACCFA and the rural banks have the same goals. They differ, however, in their approaches. At present many

[1] Central Experiment Station Contribution No. 2040. Thesis presented for graduation with the degree of Bachelor of Science in Agriculture from the U.P. College of Agriculture, March, 1959. Prepared in the Department of Agricultural Economics under the direction of Asst. Professors Basilio N. de los Reyes and Leopoldo P. de Guzman.

of the rural banks have repayment figures higher than those of the ACCFA.

This study was conducted to find out the reasons for the difference between the loan repayment figures of FaCoMas and rural banks located in the towns of Polo and Baliwag, Bulacan and operating under the same natural, economic, and social conditions. Since the survey areas were selected, not drawn at random, the results of the study should not be taken as representative of the operations of rural banks and FaCoMas in Bulacan or the Philippines, but only of those in Polo and Baliwag.

THE BORROWERS

The characteristics of borrowers are one of the most essential considerations in sound credit extension. In general, lending agencies consider age, experience, educational attainment, size of family, and occupation of borrowers before deciding on the loan application. In this study, there was no distinct difference between the characteristics of rural bank and FaCoMa borrowers.

The average age of both groups of borrowers was about 46 years. They had spent an average of 23 years in farming and 2.6 years of schooling. Majority or 93 per cent of them resided in the barrio. Two-thirds (67 per cent) of the borrowers were share-tenants.

THE FARMS

Aside from the characteristics of the borrower, some aspects of the farms are also considered by the lenders. These include the size of the farm, crops grown, production rates, and operator's share.

About 70 per cent of rural bank borrowers and 60 per cent of the FaCoMa borrowers had farms of 3 hectares or less. The primary crop grown by both groups of borrowers was lowland rice during the wet season. The average yield obtained by all borrowers was 50 cavans per hectare. During the dry season 60 per cent of the borrowers raised vegetables on upland farms. Rural bank borrowers had an average share of 64 cavans of palay. This was 8 cavans lower than the average share of FaCoMa borrowers, partly because of higher average size of farms of FaCoMa borrowers.

THE LOANS

Size of loans granted. The rural bank loans were generally bigger than the FaCoMa loans. The size of the rural bank loans ranged from ₱30 to ₱3300 or an average of ₱421: those of the FaCoMas ranged from ₱25 to ₱420 or an average of ₱129 (table 1). About 90 per cent of FaCoMa borrowers got loans of ₱200 or less; about 40 per cent of rural bank borrowers obtained loans of ₱200 or more.

TABLE 1.—*Size of agricultural loans granted by 2 rural banks and 2 FaCoMas, Bulacan, 1957-1958*

SIZE OF LOAN	RURAL BANK	FACOMA
Number of loans	52	52
	per cent	
₱100 and less	21	40
101–200	40	50
201–300	14	8
301–400	4	—
401–500	6	2
501 and above	15	—
Total	100	100
Average	₱421	₱129

Purpose. The major purpose of the two groups of farmers in borrowing was to finance transplanting expenses (table 2). Four-fifths of the FaCoMa borrowers and one-half of the rural bank borrowers listed transplanting as purpose for borrowing. Other important purposes were land preparation, subsistence, and purchase of fertilizer.

The greater variety of rural bank loan purposes is evident from table 2. It must not be concluded, however, that rural banks serve a wider area of agriculture. Actually, FaCoMas cover the same loan purposes entertained by rural banks, but because some loans (farm improvement loans) have a maximum maturity period of 3 years, they were not included among the samples. It was noted that rural banks gave more liberal amounts than the FaCoMas as loans for the same purpose. FaCoMas generally follow a loan budget where the expenditure for a certain item has a fixed maximum. Rural bank loans which are supposed to be budgeted nevertheless do not follow a fixed budget.

TABLE 2.—*Loan purposes reported by 104 borrowers of 2 rural banks and 2 FaCoMas, Bulacan, 1957-1958* [a]

PURPOSE	RURAL BANK		FACOMA	
	Per cent [a]	Value [b]	Per cent [a]	Value [b]
		pesos		
Planting	52	91	83	72
Land preparation	27	170	69	60
Subsistence	40	124	25	38
Fertilizer	44	199	13	42
Repair of buildings	4	180	—	—
Land improvement	12	917	—	—
Farm expenses	10	380	2	60
Purchase of carabao	8	242	—	—
Fishing	2	400	—	—
Others [c]	8	195	—	—

[a] Percentage based on total number of borrowers. Many borrowers reported more than one purpose.
[b] Average based on number reporting.
[c] Paying off other loans, combination of fertilizer purchase and planting.

Security. The laws which authorized the creation of rural banks and FaCoMas say that the primary consideration for giving a loan is the repayment capacity of the borrowers and not the collateral they can put up. To serve the small farmers who are not eligible for loans from collateral-strict commercial banks, chattel mortgage on present or future crops are considered acceptable collateral. FaCoMas require their borrowers to pledge part of their crop to be marketed through the FaCoMa. This pledge, known as the marketing agreement, has the same legal meaning as a chattel mortgage. In this study, all loans given by the FaCoMas were secured with only a marketing agreement (table 3). On the other hand, two-thirds of the rural bank borrowers (67 per cent) used chattel mortgage on future crops and 29 per cent used real estate mortgage.

Period of the loan. All FaCoMa loans were granted for a maximum period of 9 months. Rural bank loans had a maximum maturity period of 9 months, with an average of 7 months.

Distribution of loans by months. The rural bank loans were generally distributed throughout the year except in April (table 4). All were released in one lump sum, not according to a loan budget.

On the other hand, FaCoMa loans were almost concentrated in June, July, and August, and were released in installments accord-

ing to the time of need. The maturity date was calculated, using the date of first release.

TABLE 3.—*Kinds of security offered by 104 borrowers of 2 rural banks and 2 FaCoMas, Bulacan, 1957-1958*

SECURITY	RURAL BANK [b]	FACOMA
	per cent	
Real estate mortgage:		
1. Farm land	25	—
2. House lot	4	—
Chattel mortgage:		
1. On future crops	67	100
2. On work animal	15	—
Others [a]	6	—

[a] Pension
[b] Some borrowers offered more than one security.

TABLE 4.—*Distribution of loans by months of 104 borrowers of 2 rural banks and 2 FaCoMas, 1957-1958*

MONTH	RURAL BANK	FACOMA
	per cent	
April	29	—
May	15	—
June	11	38
July	10	31
August	10	23
September	19	4
October	4	3
November	2	1
Total	100	100

Rate of interest. Both agencies charged 12 per cent interest per annum deducted in advance. In the case of the FaCoMas, another 5 per cent was withheld by the ACCFA as "insurance" against delinquencies. This amount, however, was treated as forced savings and was supposedly to be returned to the members concerned—after full settlement of their loan accounts—in the form of stock certificates or additional investment in the capital stock of their FaCoMas.

LOAN REPAYMENT

Two measures of repayment performance were used, namely: (1) percentage of the number of loans that were repaid, partly repaid, extended or unpaid, and (2) percentage of the amount due that was settled.

Repayment by number of loans. The percentage of the total number of due loans that were not paid at all was higher among FaCoMa borrowers than among rural bank borrowers. Twenty per cent of the FaCoMa borrowers did not pay their loans, compared with 4 per cent in the case of the rural bank borrowers (table 5). However, a slightly higher proportion of FaCoMa borrowers (63 per cent) settled their obligation on time and in full compared with rural bank borrowers (56 per cent). Twenty-one per cent of the rural bank borrowers settled their obligation in full but after the maturity date. As a whole, however, rural banks had more fully-repaid loans than the FaCoMas.

TABLE 5.—*Repayment status of 104 loans of 2 rural banks and 2 FaCoMas, Bulacan, 1957-1958*

REPAYMENT STATUS	RURAL BANK	FACOMA [a]
Number of loans	52	52
	per cent	
Fully repaid (on time)	56	63
Fully repaid (late)	21	—
Partly paid	—	17
Extended	6	—
Partly paid, partly extended	13	—
Unpaid	4	20
Total	100	100

[a] FaCoMa borrowers with palay deposits in FaCoMa were considered borrowers who had settled their debts.

Repayment based on amount due. Repayment figures based on the amount due did not differ much from those based on the number of loans. Rural bank repayment averaged 86 per cent of the total amount due; FaCoMa repayment, 70 per cent (table 6). In calculating the repayment figure for the FaCoMa borrowers, the value of palay deposited in the FaCoMa by the respective borrower was considered as payment for the loan because the FaCoMas deduct the amount borrowed by borrower-depositors whenever they liquidate their palay deposits.

TABLE 6.—*Loan obligation repaid by 104 borrowers of 2 rural banks and 2 FaCoMas, Bulacan, 1957-1958*

ITEM	RURAL BANK	FACOMA [a]
	pesos	
1. Average amount granted	421	129
2. Average amount repaid	361	90
3. Percentage repaid (2 ÷ 1 × 100)	86	70

[a] FaCoMa borrowers with palay deposits in the FaCoMa were considered borrowers who had settled their debts.

ECONOMIC FACTORS AND LOAN REPAYMENT

Fulfillment of marketing agreement by FaCoMa borrowers. Marketing agreement is the promise of the FaCoMa borrower to deliver to the FaCoMa after harvest a certain quantity of palay produced. This marketing agreement is the basis of the size of loan farmers can get; at the same time, it may be used as security. It is registered with the municipal treasurer which gives ACCFA preferential lien on the produce of farmer-borrowers.

The quantity of palay which borrowers pledge to deliver to the FaCoMa for marketing and repayment of the ACCFA loan is based on the borrowers' expected surplus after allowance for family consumption is made. Among the 52 FaCoMa borrowers, the quantity of palay pledged in the marketing contract ranged from 10 cavans to 100 cavans, with an average of 37 cavans per borrower (table 7). However, only 46 per cent of the amount pledged was actually delivered.

TABLE 7.—*Fulfillment of marketing agreement of 52 FaCoMa borrowers according to cavans pledged, 2 FaCoMas, Bulacan, 1957-1958*

PLEDGE	NUMBER OF BORROWERS	AVERAGE AGREEMENT	AVERAGE DEPOSITED	PER CENT OF FULFILLMENT
		cavans		
Less than 30	18	21	13	62
30–40	21	32	16	50
Above 40	13	67	22	33
Total	52	37	17	46

There was an inverse relationship between quantity of palay pledged and success in fulfilling the marketing pledge. Those who pledged less than 30 cavans of palay delivered on the average two

thirds of the quantity pledged, while those who pledged more than 40 cavans delivered only one third of the quantity agreed upon.

Another way of looking at the problem of poor fulfillment of the marketing contract by FaCoMa borrowers is shown in table 8. About one-fifth of the borrowers did not make any deposit at all, while the same proportion deposited the exact amount or more pledged. About two-thirds of the borrowers made deposits lower than what they pledged.

TABLE 8.—*Percentage of FaCoMa borrowers who fulfilled their marketing pledge, 52 FaCoMa borrowers of 2 FaCoMas, Bulacan, 1957-1985*

EXTENT OF FULFILLMENT	NUMBER	PERCENTAGE
Did not make any deposit	10	19
Deposited less than amount pledged	32	61
Deposited exact amount pledged	4	8
Deposited more than amount pledged	6	12
Total	52	100

The drought during the year under study caused a 19 per cent decrease in the production of FaCoMa borrowers, and provided both borrowers and FaCoMa officials with a ready excuse for a repayment lower than that of rural bank borrowers. However, such a reason provided only a small part of the answer when the quantity of palay received by the FaCoMa borrowers who made full deposits was compared with that received by those who did not make any deposit (table 9). FaCoMa borrowers who did not make any deposit against

TABLE 9.—*Average quantity of palay owned by 26 FaCoMa borrowers, by status of fulfillment of marketing pledge, 2 FaCoMas, Bulacan, 1957-1958*

STATUS OF FULFILLMENT	NUMBER	BORROWER'S SHARE	PAID TO CREDITOR	PALAY AVAILABLE
		cavans		
No deposit	6	77	13	64
Part deposit	14	69	8	61
Full deposit	6	76	8	68
All borrowers	26	72	9	63

their pledge had the highest net share of palay. Assuming that those borrowers had other pressing leaders to satisfy, their net share was still higher than the average share of all FaCoMa borrowers.

The above table would indicate that the low percentage of fulfillment of the marketing agreement by FaCoMa borrowers would have to be supported with reasons other than economic.

Income-debt ratio. The measure of repayment capacity considered in short-term lending is the gross farm receipts.[2] When short-term production loans are timed to mature with the harvesting of the crop financed, debt becomes one of the first things the borrowers have to settle. Among the rural bank borrowers, no clear relationship was found between gross farm receipts and loan repayment; among the FaCoMa borrowers, an inverse relationship was found between gross farm receipts and repayment (table 10). When the ratio of gross farm receipts to amount of obligation was computed, the relationship was still the same, that is, FaCoMa borrowers who fully repaid their loans had ₱6 worth of gross farm receipts per ₱1 of obligation, while those who did not pay their loans had ₱11 of gross farm receipts per ₱1 obligation.

TABLE 10.—*Relation of income-debt ratio to loan repayment of 52 borrowers of 2 rural banks and 2 FaCoMas, Bulacan, 1957-1958*

ITEM	REPAYMENT STATUS		
	Fully repaid	Partly repaid	Unpaid
1. Rural bank borrowers, number	20	2	4
	pesos per borrower		
a. Average loan obligation	415	275	190
b. Average gross farm receipts	1052	414	537
c. Gross farm receipts per ₱1 debt (b ÷ a)	2.53	1.51	2.83
2. FaCoMa borrowers, number	18	4	4
	pesos per farm		
a. Average loan obligation	130	138	112
b. Average gross farm receipts	781	1147	1239
c. Gross farm receipts per ₱1 debts (b ÷ a)	6.00	8.31	11.06

The above table shows that in terms of farm incomes, both borrowers were good credit risks, but the FaCoMa borrowers were better credit risks than the rural bank borrowers. The rural bank borrowers had an average of ₱2.50 gross farm receipts per ₱1 of debt, while the FaCoMa borrowers had ₱8.90 gross farm receipts per ₱1

[2] L. J. Norton, "Financing agriculture." The Inter-state, Danville, Illinois, 1948, p. 115.

of debt. The fact that the rural bank borrowers repaid 86 per cent of their obligations and FaCoMa borrowers only 70 per cent makes it doubtful whether economic factors determined loan repayment more than social factors.

Assets-debt ratio. The practice of requiring collateral for loans —be it chattel mortgage or real estate mortgage or a simple promissory note—is for the protection of the lender from losses due to the failure of business financed or bad faith on the part of the able-to-pay borrower. Although all the FaCoMa loans and 67 per cent of the rural bank loans were secured with just a chattel mortgage on the future crop (palay), the two agencies had legal access to their borrowers' current and fixed assets; the marketing agreement of the ACCFA and the promissory note of the rural bank could be used by the respective agency as a basis for legal suits against the borrower; foreclosure proceedings on some of the unencumbered assets of the borrower could be instituted.

It is possible that delinquent borrowers have insufficient assets to satisfy their loans so that threat of lawsuit does not mean much to them. However, table 11 shows that the ratio of assets (both current and fixed) to amount of obligation was favorable for all

TABLE 11.—*Relation of assets-debt ratio to loan repayment of 52 borrowers of 2 rural banks and 2 FaCoMas, Bulacan, 1957-1958*

ITEM	REPAYMENT STATUS		
	Fully repaid	Partly repaid	Unpaid
1. Rural bank borrowers, number	20	2	4
		pesos per farm	
a. Average loan obligation	415	275	190
b. Current assets	748	511	1082
c. Current assets per ₱1 debt (b ÷ a)	1.80	1.86	5.70
d. Total assets	11128	2506	5093
e. Total assets per ₱1 debt (d ÷ a)	26.79	9.11	26.81
2. FaCoMa borrowers, number	18	4	4
		pesos per farm	
a. Average loan obligation	130	138	112
b. Current assets	875	932	1012
c. Current assets per ₱1 debt (b ÷ a)	6.73	6.75	9.04
d. Total assets	6404	2388	4506
e. Total assets per ₱1 debt (d ÷ a)	49.26	17.30	40.23

borrowers of both agencies and most favorable among delinquent borrowers in terms of current asset-debt ratio.

The amount of current assets per ₱1 debt was much higher among the rural bank borrowers who did not repay their loans than among those who did. The same trend was noticed among FaCoMa borrowers. The fact that the delinquent borrowers of both agencies had better repayment capacity (in terms of gross farm receipts-debt ratio) and higher debt-carrying capacity (in terms of current asset-debt ratio) than good borrowers, tended to show that economic consideration did not account significantly for causes of loan repayment delinquency. The two preceding tables have pointed out that delinquent borrowers of the FaCoMas and rural banks had the capacity to repay as well as enough assets to satisfy their loan obligations.

Reasons given by delinquent borrowers. The six delinquent rural bank borrowers and the eight delinquent FaCoMa borrowers were asked why they failed to meet their obligations. All the rural bank borrowers and six of the eight FaCoMa borrowers gave poor yield as their reason for not meeting their obligations (table 12); the remaining two FaCoMa borrowers reported that they had other pressing needs to meet. They expected, however, to repay their loans by selling crops and by borrowing from landlords and relatives.

TABLE 12.—*Causes of loan delinquency and opinions of 14 delinquent borrowers, 2 rural banks, 2 FaCoMas, Bulacan, 1957-1958*

ITEM	BORROWERS WITH PARTLY PAID LOANS		BORROWERS WITH UNPAID LOANS	
	Rural Bank	FaCoMa	Rural Bank	FaCoMa
Number of borrowers	2	4	4	4
	number of borrowers			
1. Reasons given for delinquency				
a. Poor yield	2	3	3	3
b. Need for cash for other purposes		1	1	1
2. Expected source of repayment funds				
a. Loan from landlord			2	2
b. Sale of crops	1	3	1	2
c. Loan from relatives	1	1		
d. Undetermined			1	

The reasons given above, however, were not supported by facts. The preceding tables have shown that delinquent borrowers had high-

er gross farm receipts than those who were able to pay their loans; among the FaCoMa borrowers, those who did not make any palay deposit received almost the same share of palay as those who fulfilled their marketing pledge (table 9).

An economic analysis of delinquent borrowers in relation to repayment. Before any conclusion can be made, a thorough study of the economic position of the borrowers in relation to repayment is necessary. The previous discussion, based on debt-carrying capacity and debt-paying capacity, showed that the delinquent FaCoMa borrowers had all means to pay their obligations if they had been willing to do so. Even when the debt-paying capacity was based on the net cash disposable income, the delinquent FaCoMa borrowers still had an average of ₱499, while the average for all borrowers was only ₱330 (table 13). One of the delinquent FaCoMa borrowers could afford to buy a sewing machine, but could not settle his account. Among the delinquent FaCoMa borrowers, spending an average of ₱102 for fiesta came before paying off their debts.

TABLE 13.—*Economic position of delinquent borrowers, Bulacan, 1957-1958*

ITEM	RURAL BANK	FACOMA
Number of borrowers	6	8
	pesos	
Average loan	218	125
Net cash disposable income	–241	499
Other debts	326	56
Fiesta expenses	28	102
Purchase of sewing machine	–	25

After a consideration of all possible angles of the economic position of the delinquent FaCoMa borrowers, it appears that the economic factor was not the reason for the delinquent borrowers' failure to meet their obligations.

A reverse situation comes to the picture after an analysis of the delinquent rural bank borrowers. Their debt-paying capacity was far below that of the delinquent FaCoMa borrowers. They had a negative net cash disposable income of ₱241 and were indebted for about ₱326 to other lenders; this indicated that they really had no means with which to settle their obligations. When the loans were granted to them, their net disposable income was grossly over-

estimated. This information suggests that the reason for non-payment among rural bank borrowers was economic in nature.

Another important point is that three out of the six delinquent rural bank borrowers approached the rural bank officials, admitted that they could not be able to pay, and asked for extension which was granted by the rural bank. This situation supports the belief that the filing of a lawsuit against delinquent borrowers might be an effective way of inducing them to meet their obligations.

SUMMARY AND CONCLUSION

1. The homogeneity of conditions in the study was more than what was expected. Both the rural banks and the FaCoMas gave loans to essentially the same types of borrowers.

2. The major loan security used by both agencies was the crop lien on future production. Twenty-nine per cent of rural bank loans were secured with real estate mortgage.

3. The repayment figure for rural bank loans was 86 per cent of the amount loaned; for ACCFA loans, 70 per cent. Among the FaCoMa borrowers, 20 per cent did not pay their loans; among the rural bank borrowers, 4 per cent.

4. Delinquent FaCoMa borrowers were found to have enough palay, gross farm receipts, and assets to satisfy their loans. No difference in palay shares received, gross farm receipts, and value of current assets between FaCoMa borrowers who paid all of their loans and those who were delinquent was found to infer that economic factors accounted for the low repayment figure of FaCoMa borrowers, compared with that of rural bank borrowers.

5. Delinquent rural bank borrowers were found to have lower incomes than those who were able to pay their loans. The causes for the delinquency of rural bank borrowers were high outstanding obligations to other lenders, and over-estimation of the borrowers' income.

6. Rural bank borrowers had the tendency to pay rural banks first because of the threat of a lawsuit. A great proportion of FaCoMa borrowers thought that the FaCoMas were the most lenient creditor.

7. Complaints of the FaCoMa borrowers against ACCFA loans were: (a) late arrival, (b) small size, (c) high interest, (d) short

repayment period. Few rural bank borrowers complained of the size of their loans.

8. The difference between the repayment figures of the two rural banks and the two FaCoMas seems to lie more in the attitudes of the borrowers than in their economic conditions. The ACCFA lending policy in general is as sound as that of the rural banks; however, it can stand revision and improvement at some points. A more positive educational campaign among FaCoMa borrowers on their privileges and obligations is needed to change their attitudes.

9. Among the delinquent rural bank borrowers, the economic factors were the most important reasons for their failure in repayment. To maintain or improve repayment figures, rural banks should investigate more carefully the borrowers' economic position before deciding on the amount to be lent.

RECOMMENDATIONS

1. Extensive education is necessary to make the FaCoMa members more cooperative-conscious. There should be a clear understanding between the FaCoMa members and the FaCoMa that the ACCFA loans obtained are just like any other loans which the borrowers have to repay on time and in full. Members should be made to realize that the credit privilege accorded them involves certain responsibilities.

2. A fair compensation should be given to the barrio loan committee of the FaCoMa, considering the important role it plays in the overall lending operation. On the other hand, a system which will penalize committee members for poor collection of loans or negligence in verifying loan applications should be devised.

3. Inasmuch as almost all the borrowers had work animals, houses, and other chattel properties which were not encumbered, such properties should be used as loan security. A registered chattel mortgage listing the specific properties of the borrower which would be foreclosed for default in payments might have a tremendous psychological effect on the borrowers; it might compel them to meet their obligations on time and in full. The basis for the loans should still be the marketable surplus of the farmer.

4. Filing of lawsuits against delinquent FaCoMa borrowers who have the capacity but not the desire to pay is necessary to maintain

the business relationship between the FaCoMa and the borrower. This action should not be considered as a handicap in fostering cooperation. For the success of a cooperative, the members should know what their rights and their responsibilities are.

5. There were indications that some FaCoMa officials oriented the FaCoMa policies for use in future political plans. FaCoMa policies should never be influenced by the political aspirations of its officials or the majority of its members.

6. The ACCFA should release the loans on time so that the farmers can use them when they are needed; discontent among them can thus be avoided.

7. The rural banks should investigate carefully the prospective borrowers' repayment capacity in relation to the size of the loan to be granted.

THE RESPONSE OF SOME LOWLAND RICE VARIETIES TO 2,4-DICHOLOROPHENOXYACETIC ACID (2,4-D) [1]

MARCOS R. VEGA and SANTIAGO R. OBIEN

WITH EIGHT TEXT FIGURES

Data indicate that of the Seed Board-recommended varieties studied, Peta is relatively susceptible; B-E-3 on the other hand can withstand 2,4-D spraying fairly well. The rest of the varieties fell intermediate between Peta and B-E-3.

It is evident that if the suggested rate of spraying is used and spraying is done at the proper stage, the variety may be of minor consideration in deciding whether or not to use 2,4-D in control. However, if it is necessary that a higher concentration be applied at an earlier date, it may be better to use B-E-3. In this case, the use of Peta should be avoided.

A difference in grain yield was observed by Fertig and Vega (1956)[2] between Thailand and Guinangang varieties of rice sprayed with 1.68 kilograms of 2,4-D per hectare. Smith (1957) sprayed six varieties of rice (Cody, Zenith, Arkrose, Nato, Century Petna 231, and Improved Blue Bonnet) at different stages of growth and with different concentrations of 2,4-D. In the first trial he observed similar responses to 2,4-D at the various stages of growth; he did find differences, however, among the varieties on the second year of the experiment

It is known that the effects of 2,4-D on a certain species (or the response of a certain species to 2,4-D) may be influenced by the concentration of 2,4-D and/or the stage of growth at which the plant is sprayed. If differences occur then in the response of rice varieties to 2,4-D they may be attributed to these factors. For instance, Fertig and Vega (1956)[3] observed a difference in yield between Thailand and Guinangang when sprayed with 1.63 kilograms of 2,4-D per hectare while no difference was noted when the concentration of 2,4-D used was 0.84 kilogram per hectare. These observations agree with those of Kusch (1947) when he sprayed four-inch tall

[1] Central Experiment Station Contribution No. 2041. Part of Project No. 22, Rice & Corn Production Program.

[2] S. N. Fertig and M. R. Vega, "The use of herbicides for the control of weeds in lowland rice." 1956. (Unpublished).

[3] *Ibid.*

cereal grains with four rates of 2,4-D ester (0.28, 0.56, 1.12, and 2.24 kilograms per hectare). While he did not find any varietal differences on any of the crops he used (wheat, oats, and barely) at the 0.28 and 0.56 kilogram per hectare rates, he did observe differences at the rate of 1.12 and 2.24 kilograms per hectare.

To take care of these two factors likely to influence response of rice varieties to 2,4-D, the rice plants being studied were sprayed at two growth stages with two concentrations of 2,4-D. The two concentrations employed were 0.84 and 1.40 kilograms per hectare, sprayed when the rice were 20 and 40 days of age. Previous work indicated that where 2,4-D reduces yield of rice, the lower yield per plant compared to untreated ones can almost always be traced to the fewer number of panicles harvested from the former plants. This fewer number of tillers is a reflection of the inhibition of tiller production resulting from 2,4-D treatment. Thus, de la Fuente (1956) deduced that rice plants become tolerant of 2,4-D sprays after they have produced about 90 per cent of the maximum number of tillers they can produce; they are, on the other hand, most susceptible when sprayed immediately prior to the start of tiller production. Spraying at 40 days of age was calculated to correspond to the tolerant stage, and at 20 days, to the susceptible stage.

The varieties used, except one, were included in the list of recommended varieties by the Philippine seed board (1958). The experiments were conducted in the Department of Agricultural Botany from March to December, 1959.

MATERIALS AND METHODS

Two separate experiments were conducted: in Experiment I, the varieties were sprayed at 40 days of age and in Experiment II, the varieties were sprayed at 20 days of age. In Experiment I, the varieties studied were B-E-3, Intan, Peta, Tjahaja and Tjere Mas; in Experiment II, Milfor 6 and Raminad were used in addition to the five varieties used in the first experiment.

Rice seeds were soaked in water and then germinated in Petri dishes until they were four to five days old. Then, they were transplanted to earthen pots (size no. 9) containing soil maintained under simulated lowland conditions. At the appropriate date, the plants were sprayed with either 0.84 or 1.40 kilograms in 37 gallons of water per hectare. Therefore, for each variety in each experiment, a treatment consisted of 0 (control), 0.84, and 1.40 kilograms of

2,4-D per hectare. All treatments were replicated four times. Pots were kept free from weeds during the study.

The number of tillers, the growth in height, and the yield of grains were observed. Yield data included the number of harvested panicles, dry weights of grains, and weight of grains per panicle. The length of panicles (length occupied by grains) was also recorded in experiment II. An additional set of data recorded soon after spraying was the angle formed by the tillers with the vertical. Data obtained were analyzed statistically whenever deemed necessary.

RESULTS AND OBSERVATIONS

Effect on growth in height

Experiment I. The height of plants was measured from the base to the tip of the longest leaf. There is no doubt that one of the effects of herbicidal concentrations of 2,4-D is the inhibition of growth, which is apparently true regardless of the variety, or of the date of spraying, be it 20 or 40 days after planting (fig. 1 to 3). This adverse effect of 2,4-D on growth in height ordinarily

Fig. 1.—The effects of two concentrations of 2,4-D on variety Peta sprayed at 20 days of age.
Planted: June 6, 1959
Sprayed. June 26, 1959
Photographed: August 3, 1959

Fig. 2.—The response of variety Tjere Mas to two concentrations of 2,4-D sprayed at 20 days of age. Note downward leaf emergence in plant sprayed with 1.40 kilograms 2,4-D per hectare.
Planted: June 6, 1959
Sprayed: June 26, 1959
Photographed: August 3, 1959

Fig 3.—The effect of two concentrations of 2,4-D on variety B-E-3 sprayed at 20 days of age.
Planted: June 6, 1959
Sprayed: June 26, 1959
Photographed: August 3, 1959

is only temporary, i.e., if the increment in height of treated and untreated plants was followed, the increase in height of treated plants would equal or even surpass that of untreated plants. It is therefore natural for treated plants to be finally taller than those which were not sprayed (table 1).

TABLE 1.—*Effect of 2,4-D on the height of recommended lowland varieties*

VARIETY	CONC. OF 2,4-D KGS./HA.	START OF INHIBITION, DAYS AFTER SPRAYING		RECOVERY FROM INHIBITION, DAYS AFTER SPRAYING		FINAL HEIGHT (cm.)	
		Sprayed at 20 days	Sprayed at 40 days	Sprayed at 20 days	Sprayed at 40 days	Sprayed at 20 days	Sprayed at 40 days
B-E-3	0					97.25	108.75
	0.84	0	10	7	21	93.50	109.66
	3.40	0	5	7	21	78.25	108.50
Intan	0					109.25	118.25
	0.84	0	5	7	15	98.25	114.75
	1.40	0	0	14	21	94.00	112.00
Peta	0					98.50	110.00
	0.84	0	0	28	21	88.33	117.00
	1.40	0	0	†	21	—	116.75
Tjahaja	0					99.25	112.75
	0.84	0	0	7	15	102.25	120.00
	1.40	0	0	14	21	94.50	118.00
Tjere Mas	0					90.00	106.25
	0.84	0	0	7	21	97.25	107.50
	1.40	0	0	14	15	93.66	110.50
Raminad	0					111.75	
	0.84	0		14		118.00	
	1.40	0		21		117.50	
Milfor 6	0					85.25	
	1.40	0		21		88.50	

† Plants died.

From the data obtained, it was apparent that differences among the varieties could be discerned if the number of days from spraying to the onset of inhibition was considered. In varieties Peta, Tjere Mas, and Tjahaja, the effect of 2,4-D was apparent immediately after spraying. The increase in height from spraying to the first height measurement after spraying (5 days after spraying) was relatively lower among treated plants (both with the 0.84 and 1.40 kilogram

per hectare rates) compared to the unsprayed plants. In B-E-3, it took five and 10 days for 2,4-D to take effect with 1.40 and 0.84 kilogram per hectare rates, respectively. With Intan, it took five days after spraying 0.84 kilogram per hectare for the stunting effect to become apparent (table 1, column 4).

The number of days from spraying until the recovery of the plants from the inhibiting effect varied from 15 to 21 days, with no definite indication that one variety recovered faster than the other. A plant was considered to have recovered from the effect when the increment in height among treated plants was about the same or was greater than that observed from the control (table 1, column 6). Subtracting the days it took for inhibition to start from the days it took the plants to recover from the stunting effect, the approximate number of days the effect of 2,4-D persisted in the plant was obtained. This ranged from 11 to 21 days among the varieties used.

It will be noted that at the last measurement, the height of treated plants was comparable to that of the unsprayed plants; in some cases, treated plants were higher than the controls. Reduction, where it occurred, as in B-E-3 and Intan, was only as much as 6 centimeters (Intan sprayed with 1.40 kilograms of 2,4-D per hectare). In Peta, Tjahaja, and Tjere Mas, the treated plants were even higher than their respective controls (table 1). It should be noted that it was in these three varieties that the inhibiting effect of 2,4-D was apparent immediately after spraying.

Experiment II. The inhibiting effect of 2,4-D became apparent immediately after spraying all the varieties studied. Again it seems that B-E-3 has an edge over the others: even when sprayed with the higher concentration, it only took seven days for this variety to recover from the stunting effect of 2,4-D while the other varieties needed as many as 28 days after spraying (table 1, column 3 and 5). Reduction in final height of plants was observed in B-E-3, Intan, and Peta; increased heights were noted among Tjere Mas, Raminad, and Milfor 6 (table 1, column 7).

Effect on tiller production

Experiment I. In some varieties (Peta, B-E-3, and Intan), a nearly maximum number of tillers was produced at the time of spraying; in Tjahaja and Tjere Mas, the number was attained after five days. That is, in the latter two varieties, the tillers were being

initiated and/or were about to emerge when spraying was done. It was not surprising therefore that 30 days after spraying, the number of tillers (expressed as per cent of the control) in Tjahaja and Tjere Mas were lowest (table 2). In Tjere Mas for instance, the

TABLE 2.—*Effect on tiller production of recommended lowland varieties sprayed with 2,4-D at 40 days of age*

VARIETY	CONC. OF 2,4-D (KGS./HA.)	AT SPRAYING		FIVE DAYS AFTER SPRAYING		THIRTY-FIVE DAYS AFTER SPRAYING	
		Number	% of control	Number	% of control	Number	% of control
B-E-3	0	34.00		34.75		33.50	
	0.84	36.25	106.61	37.25	107.19	33.75	100.75
	1.40	34.25	100.73	34.75	100.00	33.50	100.00
Intan	0	33.25		38.25		36.50	
	0.84	40.00	120.30	40.75	106.53	41.75	114.38
	1.40	39.25	118.04	40.50	105.88	38.00	104.10
Peta	0	35.50		39.50		37.25	
	0.84	37.75	106.33	39.25	99.67	36.50	97.98
	1.40	39.25	110.56	40.25	101.89	35.75	95.97
Tjahaja	0	31.00		36.75		37.75	
	0.84	34.25	110.48	36.75	100.00	35.25	93.37
	1.40	37.75	121.77	38.25	104.08	36.75	97.35
Tjere Mas	0	42.25		47.75		49.50	
	0.84	40.75	96.44	42.50	89.00	41.50	83.83
	1.40	37.75	89.34	39.75	83.24	38.25	77.27

number of tillers of plants sprayed with 1.40 kilograms per hectare was only 77.27 per cent of the control. On this basis, it seems that of the varieties studed, Tjere Mas is more susceptible than the others. This can be explained by the fact that at 40 days of age, Tjere Mas was still producing tillers. In the sprayed plants, these tillers were delayed or were prevented from emerging; while in the unsprayed plants, the tillers emerged as usual. Thus, the discrepancy in number between treated and untreated plants resulted. Where the maximum number of tillers have been produced at spraying, as in variety B-E-3, the number of tillers in treated and untreated plants was comparable.

Experiment II. The inhibiting effect of 2,4-D on tillering of rice was made more apparent. The range of the number of tillers in the different varieties dropped from 54.14 to 146.15 per cent of the

control at the time of spraying, to 7.44-39.56 per cent of the control 15 days after spraying. This is also explained in that while the number of tillers of untreated plants increased by as much as nine times, the number in treated plants practically remained the same. However, during the 15 to 30 days after spraying period, the number of tillers among sprayed plants started to increase, indicating, among other things, recovery from the effect of 2,4-D (table 3).

TABLE 3.—*Effect of 2,4-D on the increase in the number of tillers of recommended rice varieties*

VARIETY	CONC. OF 2,4-D KGS./HA.	DAYS AFTER SPRAYING			
		0-15	15-30	30-43	43-63
B-E-3	0	29.3	34.5	(20)*	(17.5)
	0.84	5.5	8.5	19.3	15.0
	1.40	1.0	9.3	14.3	22.3
Intan	0	41.6	21.5	(2.8)	25.0
	0.84	(1.3)	7.5	8.3	16.8
	1.40	(1.0)	5.3	3.7	16.3
Peta	0	16.3	34.8	1.3	(16.0)
	0.84	(0.3)	(0.3)	4.5	27.0
	1.40	—	—	—	—
Tjahaja	0	19.5	31.0	(1.0)	(10.5)
	0.84	2.3	7.5	(1.0)	28.8
	1.40	0	5.4	10.7	18.0
Tjere Mas	0	19.5	30.5	2.0	(11.3)
	0.84	5.0	12.5	14.0	12.5
	1.40	0.3	6.5	8.8	24.0
Raminad	0	28.5	32.5	(0.5)	(9.0)
	0.84	3.3	14.3	8.5	9.5
	1.40	(0.8)	2.0	10.3	37.5
Milfor 6	0	8.8	12.5	0	(0.8)
	0.84	(0.3)	0	2.5	6.0
	1.40	0	(0.3)	1.8	9.8

* Figures in parenthesis indicate a decrease in number.

Peta and Milfor 6 were conspicuously more sensitive than the other varieties. It was only in Peta where death occurred when sprayed with 1.40 kilograms per hectare. There were no casualties in Milfor 6, but production of tillers was delayed. Both Peta and Milfor 6 started producing their tillers only 30 to 43 days after

spraying as contrasted with 15 to 30 days for the other varieties. Because of this delay, increases in the number of tillers were noted among treated plants even while decreases among untreated plants were observed (table 3). It is evident from previous experience that this death of some tillers is "natural".

Gross morphological effects

Experiment I. Morphological changes occurring soon after application of 2,4-D have been described by Kaufman (1953), Vega (1954), de la Fuente *et al.* (1956), and Ona (1959).[4]

These changes included spreading of tillers, bending of leaf blades, formation of "onion leaf", and yellowing of the older leaves. Most of these gross morphological effects were also observed; however, based on these morphological effects, no apparent difference in response among the varieties could be seen.

In this study, the angle formed by the spreading tillers with the vertical was measured. During treatment, a stick was inserted vertically into the soil beside a tiller. The angle formed by the tiller with this stick was measured at intervals after spraying. It seemed that all varieties were equally affected, i.e., very soon after spraying, their tillers spread. Rice plants sprayed at this stage seem to recover from this effect of 2,4-D in about 50 days after spraying (table 4).

Experiment II. The spreading effect of 2,4-D on tillers was also noted soon after spraying. Although no measurement was made beyond 18 days after spraying, it was clear that the sprayed plants have started to recover by this time, as shown by the decreasing angle between the vertical and the tiller from three to 18 days after spraying (table 4).

Effect on flowering

Experiment I. Two aspects of 2,4-D effect on flowering were investigated: first, its effect on the number of days from planting to start of flowering, and second, its effect on the number of flowers that emerged per day. A plant was considered to have started flowering when at least one panicle has emerged.

[4] J. D. Ona, "A further study on timing the application of herbicides on rice." Thesis presented for graduation with the degree of Bachelor of Science in Agriculture, 1959. (Unpublished).

TABLE 4.—*Effect of 2,4-D on the spreading of tillers in rice plants*

VARIETY	CONC. OF 2,4-D	ANGLE FORMED (DEGREES), DAYS AFTER TREATMENT				
		3		18		50
		40 [2]	20 [1]	20	40	40
B-E-3	0	18.8	17.5	15.8	9.5	6.3
	0.84	37.5	47.5	23.8	26.5	7.3
	1.40	37.5	45.0	13.8	25.0	10.8
Intan	0	17.5	20.0	14.3	8.3	5.3
	0.84	45.0	48.8	15.0	27.3	8.0
	1.40	50.0	51.3	25.0	29.5	9.0
Peta	0	21.0	20.0	15.0	6.8	6.3
	0.84	27.5	36.3	37.5	27.8	8.0
	1.40	—	45.0	—	33.0	9.3
Tjahaja	0	16.3	17.5	12.5	7.3	7.8
	0.84	35.0	50.0	18.8	30.8	8.8
	1.40	51.3	45.0	28.8	36.3	10.0
Tjere Mas	0	15.0	17.5	10.8	10.5	8.0
	0.84	32.5	50.0	20.0	27.8	8.8
	1.40	60.0	45.0	27.5	32.3	10.8
Raminad	0	15.0		15.0		
	0.84	52.5		22.5		
	1.40	63.8		37.5		
Milfor 6	0	18.8	18.8	25.0		
	0.84	32.5	35.0	27.5		
	1.40	40.0	46.0	38.8		

[1, 2] Sprayed at 20 and 40 days of age, respectively.

A delay in the start of flowering was definitely noted in Intan. In this variety, it was also evident that a higher concentration effected a greater delay in the start of flowering (fig. 4). The start of flowering was slightly hastened in Tjere Mas which was sprayed with the higher concentration, and in Tjahaja and Peta at both levels of 2,4-D concentration (table 5 and fig. 5). Flowering in B-E-3 seemed unaffected. This may be explained by the fact that since B-E-3 is a photoperiodic variety the delay of flowering in the control for about 96 days may have nullified whatever effect 2,4-D has on flowering.

Fig. 4.—The effect of 2,4-D on flowering of Intan sprayed at 40 days of age.
Sprayed: April 22, 1959
Photographed: July 10, 1959

Aside from the hastening effect of 2,4-D on the flowering in Peta and Tjere Mas, it was noted that in these two varieties the

TABLE 5.—*Effect of 2,4-D on the start of flowering of rice*

VARIETY	CONC. OF 2,4-D KGS./HA.	NO. OF DAYS FROM PLANTING TO START OF FLOWERING		PER CENT EMERGENCE AT START OF FLOWERING (based on max. no.)	
		20	40	20	40
B-E-3	0	148	232	12.90	14.67
	0.84	150	232	5.88	10.43
	1.40	150	232	12.90	19.54
Intan	0	98	115	2.63	2.08
	0.84	104	119	2.40	1.06
	1.40	107	127	5.61	28.40
Peta	0	105	116	32.40	0.90
	0.84	111	115	3.03	2.23
	1.40	—	115	—	4.21
Tjahaja	0	121	145	3.05	0.95
	0.84	118	143	2.99	3.00
	1.40	122	143	1.88	1.88
Tjere Mas	0	98	116	1.78	0.79
	0.84	97	116	11.11	1.73
	1.40	101	114	0.85	5.82
Raminad	0	157		0.85	
	0.84	157		4.93	
	1.40	157		1.52	
Milfor 6	0	85		20.27	
	0.84	87		10.00	
	1.40	87		1.75	

number of panicles that emerged per day shortly after the start of flowering was bigger among the treated than in the untreated plants. For instance, in Tjere Mas, 6.3, 8.0, and 13.3 panicles emerged in plants treated with 0, 0.84, and 1.40 kilograms of 2,4-D per hectare, respectively (table 6).

Experiment II. In some varieties, 2,4-D also delayed the start of flowering while it hastened the process in others. In B-E-3, Intan, Peta, and Milfor 6, the start of flowering was delayed, the longest delay being observed with Peta (fig. 6 and 7). In Tjere Mas and Tjahaja, the lower concentration of 2,4-D hastened the start of flowering while the higher concentration delayed the process. In Raminad, the start of flowering was unaffected (table 5).

Fig. 5.—The effect of 2,4-D on flowering of Peta sprayed at 40 days of age.
Sprayed: April 22, 1959
Photographed: July 10, 1959

TABLE 6.—*Effect of 2,4-D on panicle emergence of some rice varieties sprayed at 40 days of age*

VARIETY	CONC. OF 2,4-D KGS./HA.	NUMBER OF PANICLES AT INDICATED DATES OF OBSERVATION								
		7-3	7-7	7-8	7-9	7-10	7-13	7-20	7-23	7-29
Intan	0	0.5	1.0	1.0	1.0	1.8	6.8	21.0	22.3	23.8
	0.84	0	0	0	0	0.3	0.5	11.0	18.5	23.5
	1.40	0	0	0	0	0	0	6.3	14.5	21.0
Peta	0	0	0.3	0.5	1.0	1.8	9.0	25.3	27.0	27.5
	0.84	0.5	1.0	1.8	4.0	6.3	10.8	23.0	23.5	23.5
	1.40	1.0	2.3	5.0	8.8	11.8	18.3	22.3	23.0	23.3
Tjere Mas	0	0.3	0.5	0.5	1.0	1.3	6.3	23.3	27.5	31.3
	0.84	0.5	0.5	1.3	1.3	2.8	8.0	22.5	25.8	28.5
	1.40	1.5	1.5	1.5	3.5	6.0	13.3	22.5	25.3	25.8

Fig. 6.—The effect of 2,4-D on flowering of Intan sprayed at 20 days of age. Start of flowering was delayed more so at the higher concentration.
Sprayed: June 26, 1959
Photographed: Sept. 21, 1959

It was again observed that in Tjere Mas, the number of panicles that emerged per day shortly after the start of flowering was bigger among treated than among untreated plants.

Effects on yield

Experiment I. Although several criteria for yield were taken, the weight of filled grains per plant is probably the most important. The 2,4-D spray did not adversely affect yield of all varieties; in Intan, yield from plants sprayed with 1.40 kilograms of 2,4-D per

Fig. 7.—The effect of 2,4-D on flowering of Peta sprayed at 20 days of age. The start of flowering was delayed.
Sprayed: June 26, 1959
Photographed: Sept. 26, 1959

hectare was significantly higher than yield from untreated plants. In the other varieties, differences between treatments within a varie-

ty were insignificant. If the number of panicles harvested per plant is taken into account, it will be noted that at least in B-E-3, Peta, and Tjere Mas, the number harvested from treated plants was fewer than those harvested from untreated plants. Logically then, the untreated plants should yield more grains. The observation that treated plants had yields comparable to those of the unsprayed ones can be explained by the fact that treated plants had bigger panicles than unsprayed ones (table 7).

TABLE 7.—*Effect of 2,4-D on the yield of some lowland varieties*

VARIETY	CONC. OF 2,4-D KGS./HA.	NO OF HARVESTED PANICLES		DRY WEIGHT OF FILLED GRAINS		WEIGHT OF GRAINS/PANICLES		% OF UNFILLED GRAINS	
		20	40	20	40	20	40	20	40
				grams		*grams*			
B-E-3	0	31.0	27.3	48.25	50.22	1.56	1.85	3.05	1.27
	0.84	25.5	22.8	54.00	41.82	2.11	1.84	5.21	1.83
	1.40	23.3	21.8	44.80	49.42	1.90	2.27	3.13	2.13
	H.S.D. 5%	6.51	4.24	*	*	0.40	*		
Intan	0	23.5	24.0	53.00	46.35	2.00	1.94	7.82	9.33
	0.84	20.8	23.5	41.00	57.75	2.14	2.45	7.65	8.26
	1.40	22.3	22.0	46.47	63.12	2.51	2.89	10.54	4.58
	H.S.D. 5%	*	*	*	12.18	*	0.51		
Peta	0	27.0	27.5	43.95	48.70	1 62	1.77	10.97	13.95
	0.84	21.3	22 3	45.45	52.00	2 18	2.30	10.56	10.69
	1.40	—	23.8	—	54.30	—	2.28	—	13.14
	H.S.D. 5%	*	4.52	*	*	*	0.32		
Tjahaja	0	32.8	26.3	51.07	55.80	1.57	2.12	6.75	6.17
	0.84	25.0	25.0	50.25	54.70	1.99	2.19	6.51	6.17
	1.40	23.5	26.5	43.72	54.75	1.85	2.01	9.57	6.92
	H.S.D. 5%	*	*	*	*	*	*		
Tjere Mas	0	28.0	31.5	43.70	52.52	1 55	1.67	11.39	13.18
	0.84	24.8	28.8	44.52	53.00	1.73	2.01	10.99	10.86
	1.40	29.3	25.8	47.86	58.45	1 63	2.27	12.60	8.88
	H.S.D. 5%	*	4.58	*	*	*	0.11		
Raminad	0	28.8		40.22		1.40		5.47	
	0.84	20.3		36.92		1.80		5.83	
	1.40	32.8		56.52		1.73		7.03	
	H.S.D. 5%	8.89		19.27		*			
Milfor 6	0	18.5		39.92		2.16		2.68	
	0.84	12.5		39.17		2.91		3.40	
	1.40	14.3		42.97		3.00		5.80	
	H.S.D. 5%	5.49				0.55			

* Not significant.

Experiment II. Except in Raminad where treatment increased the yield of grains, differences between treated and untreated plants among the other varieties were insignificant, although untreated plants had more panicles. This was due to the larger panicles of treated plants as compared to those of the untreated ones. Also noted was the higher percentage of bearing clums among treated plants (table 8).

TABLE 8.—*Effect of 2,4-D on the panicle characteristics of some lowland varieties*

VARIETY	CONC. OF 2,4-D KGS./HA.	NO. OF HARVESTED PANICLES		NO. OF TILLERS W/O PANICLES		% BEARING CULMS		LENGTH OF PANICLES
		20	40	20	40	20	40	20
B-E-3	0	31.0	27.3	39.0	7.5	44.3	78.4	21.0
	0.84	25.5	22.3	37.0	14.5	48.6	61.1	22.3
	1.40	23.3	21.8	26.5	13.0	46.7	62.6	22.7
	H.S.D. 5%	6.51	4.24					*
Intan	0	28.5	24.00	41.3	14.3	40.9	62.7	22.4
	0.84	20.8	23.50	15.3	18.3	57.6	56.3	24.3
	1.40	22.3	22.0	10.5	18.5	67.9	54.3	24.2
	H.S.D. 5%	*	*					1.46
Peta	0	27.0	27.5	28.0	12.0	49.1	69.6	22.3
	0.84	21.8	22.3	13.6	16.9	61.6	56.9	23.6
	1.40	—	23.8	—	16.5	—	59.0	—
	H.S.D. 5%	*	4.52					*
Tjahaja	0	32.8	26.3	23.3	11.5	58.5	69.5	25.8
	0.84	25.0	25.0	15.7	11.8	61.4	68.0	27.1
	1.40	23.5	26.5	13.8	11.8	63.0	69.3	26.3
	H.S.D. 5%	*	*					*
Tjere Mas	0	28.0	31.5	28.8	18.0	49.3	63.6	23.7
	0.84	24.8	28.8	21.3	13.8	53.8	67.6	23.7
	1.40	29.3	25.8	15.3	14.0	65.7	64.8	23.7
	H.S.D. 5%	*	4.58					
Raminad	0	28.8		37.5		43.4		20.6
	0.84	20.3		33.0		46.8		21.6
	1.40	32.8		22.8		59.2		22.5
	H.S.D. 5%	8.89						1.69
Milfor 6	0	18.5		6.3		74.7		24.1
	0.84	12.5		2.0		86.2		27.8
	1.40	14.3		1.5		90.5		28.9
	H.S.D. 5%	5.49						1.30

* Not significant.

This means that a greater portion of the tillers produced by untreated plants did not come to head, unlike those of the sprayed plants which did. In general, the reverse was observed when the plants were sprayed at 40 days of age.

DISCUSSION

The main advantage derived from the use of 2,4-D in rice production is that it can prevent decrease in grain yield. This can be achieved as a consequence of weed control. Maximum advantage can be derived only if 2,4-D is used wisely. Previous reports have emphasized the importance of the proper concentration of 2,4-D and the proper growth stage of plants at spraying. The present study attempted to find out whether or not the rice variety would play any role in determining the degree of success that could be obtained from the use of 2,4-D. The ultimate measure of success is grain yield obtained as a result of the treatment; but it must be emphasized that it is the initial effects of 2,4-D that determine, to a very large extent, the yield.

The worst that could happen in the use of 2,4-D is death of the plants. In this study, death occurred only in Peta variety, which was sprayed with 1.40 kilograms of 2,4-D per hectare at 20 days of age. While this concentration of 2,4-D is higher than the suggested rate, and the plant was sprayed at a susceptible stage, the observation nevertheless makes clear the relative susceptibility of Peta variety compared to the others. But when the same concentration was applied to B-E-3, at the same age in days after planting, it was found out that this variety can tolerate 2,4-D fairly well. The rest of the varieties fell intermediate between Peta and B-E-3.

None of the treatments significantly reduced grain yield per plant in any of the varieties used. This can mean that as long as a plant survives the initial effects of 2,4-D, it is capable of overcoming these adverse effects and functioning as a "normal" plant. It is clear, however, that due to 2,4-D, fewer panicles per plant were obtained. This condition was especially true among plants, regardless of the variety, sprayed at 20 days of age. As was pointed out earlier, this is a reflection of the adverse effect of 2,4-D on tiller production. The comparable yield of grains per plant between the treated and untreated plants of a variety in spite of the fewer panicles harvested from the former can be explained, at least in those sprayed at 20 days of age, by bigger panicles obtained from such plants (fig. 8). Data on per cent bearing culms may partly

Fig. 8.—The effect of 2,4-D on the size of rice panicles. Rice was sprayed at 20 days of age.

explain this condition. The per cent bearing culms was obtained by dividing the number of harvested panicles by the maximum number of tillers produced by the plant. The per cent bearing culms was higher among treated than untreated plants. This meant, for instance, that in the case of B-E-3, 39.0, 27.0, and 26.5 tillers just dried up instead of bearing a panicle. It could mean that 2,4-D, in preventing the production of more tillers (tillers that would not come to head anyway) may have brought about a diversion of more food and/or energy to the production of bigger panicles instead of maintaining these tillers which would eventually die.

When spraying was done at 40 days of age, 2,4-D delayed start of flowering in Intan, while it slightly hastened the process in Tjere Mas, Tjahaja, and Peta. When sprayed at 20 days of age, delay was noted in B-E-3, Intan, Peta, and Milfor 6; the lower concentration hastened the start of flowering in Tjere Mas and Tjahaja, while the higher concentration delayed the process in these varieties. Apparently, the age in days at spraying is more important than the variety in determining if 2,4-D would delay or hasten start of flowering. It was found that spraying at 20 days of age delays flowering more than spraying at 40 days of age. This could be explained in part by the more severe injuries that the rice suffer as a result of spraying 2,4-D at this stage which means in turn requiring a longer period of time for the plants to recover.

Summing up the work, it seems, especially when the suggested rate of spraying is used and spraying is done at the proper growth stage, that the variety plays a minor role in determining success in the use of 2,4-D for weed control. If it is, however, necessary that a higher concentration be applied at an early date, then B-E-3 of the varieties studied may be of better use than any other variety, and the use of Peta should be avoided.

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